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AN OUTLINE OF THE DEVELOPMENT OF THE AMERICAN LOCOMOTIVE.—I.

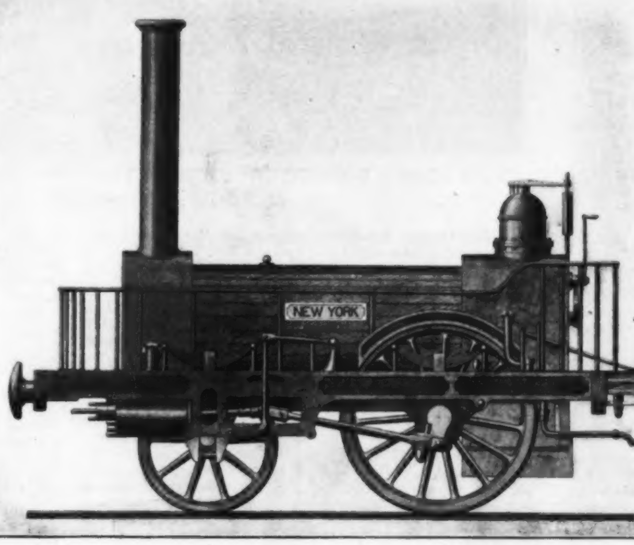
THERE is on exhibition in the Department of Transportation of the United States at the Paris Exposition a series of drawings executed under the direction of Mr. George L. Fowler, of New York, illustrating the development of the American locomotive to its present condition from the early crude designs that were imported from England. The series consists of sixteen drawings which, while far too small in number to cover the field as thoroughly as could be desired, is still sufficiently large to show types of construction during each decade of the railroad history of the country.

Special attention has been paid to the road engines since, owing to the limited number of drawings, it was impossible to cover the whole field, hence switching and other special types of locomotives have been entirely neglected.

Through the courtesy of Mr. Willard A. Smith, the director of transportation for the United States, we are able to present half-tone reproductions of these drawings.

The earliest engine shown (No. 1) is the locomotive known as the "John Bull," and is one of the few early locomotives that still remain. It is now on exhibition in the National Museum at Washington, D. C. The engine was built by George and Robert Stephenson at Newcastle-on-Tyne in 1831 and arrived in Philadelphia in August, 1831, whence it was transferred to Bordentown, N. J., on September 4 of the same year. The original dimensions of the engine were: Cylinders, 9 inches diameter by 20-inch stroke; one pair drivers, 4 feet 6 inches diameter; and one pair of wheels, not coupled, of the same diameter. The hubs were of cast iron, the spokes and rims of wood, tires of wrought iron, and the total weight about 10 tons. The engine was first put under steam September 15, 1831, and the first public trial was November 12 of the same year; Isaac Dripps acting as engineer, Benjamin Higgins as fireman, and R. L. Stevens, the founder of the Camden & Amboy Railroad, as general instructor and conductor.

The "John Bull" remained at Bordentown until 1833, the road being worked by horses up to that year. Then steam locomotion was adopted and the "John Bull" ran in regular service until 1866. The engine was somewhat modified after its receipt in this country, but the picture shows it as it was when running in 1836. In 1876 the engine was repaired and exhibited at the Centennial Exposition in Philadelphia, and in 1883 it was again shown at Chicago at the Exposition of Railway appliances. The Pennsylvania Railroad, by whom the engine was owned, then presented it to the United States government for the National Museum at Washington, and afterward borrowed it for exhibition at the World's Fair in Chicago. The present weight of the engine is 22,000 pounds in working order, and of the engine and tender 32,000 pounds. At the time of the World's Fair new tubes were put in the engine and it was sent from New York to Chicago under its own steam and hauling a train of two cars.



No. 2.—THE "NEW YORK," BUILT IN 1834 BY MATHER, DIXON & COMPANY FOR THE PETERSBURG RAILROAD.

The engine is, of course, fitted with valves operated by hooks which are located in front of the smoke box and are controlled by levers worked at the foot plate. One noticeable feature about the engine is the small size of the plates used in the construction of the boiler, indicating the limited resources available to builders at the time of its construction.

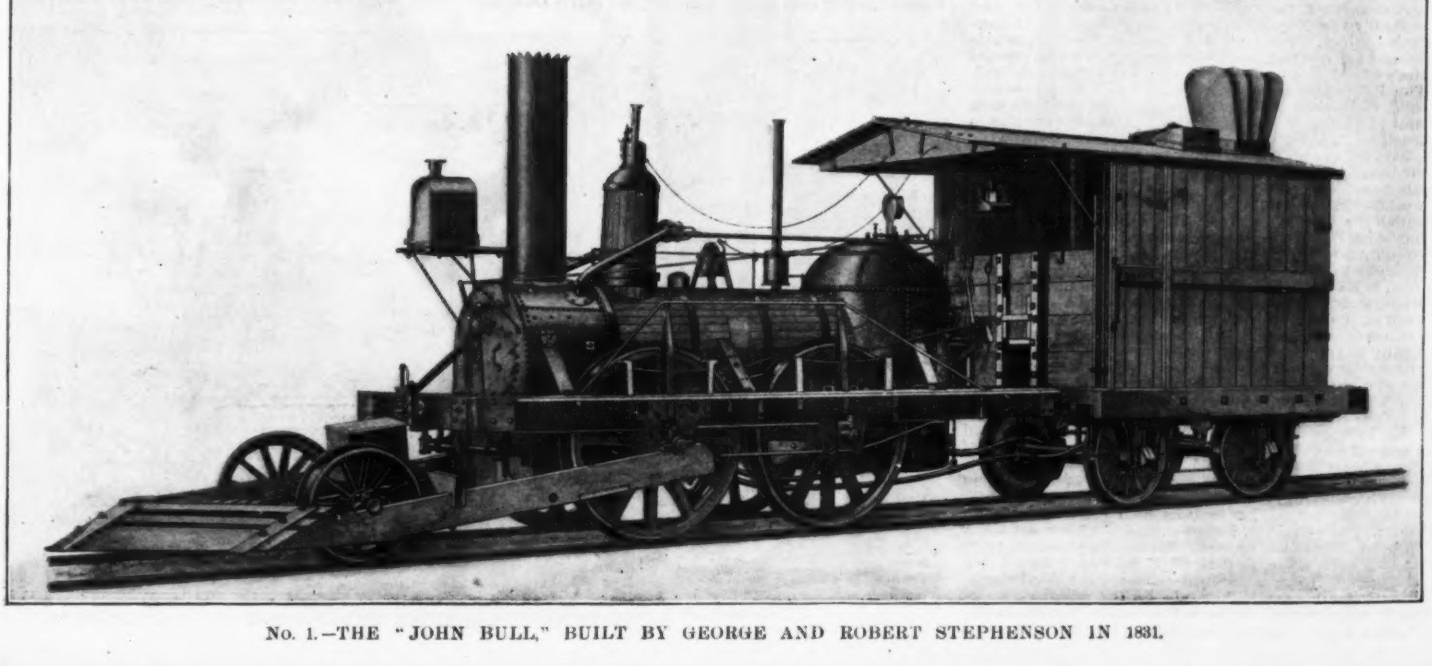
As already stated the engine was slightly modified after being put into service. The modifications consisted, in part, of the addition of the pilot carried by its own wheels at the front and a protective hood at the back of the tender by which a shelter was provided for a lookout whose duty it was to watch and guard against rear-end collisions; the occurrence of one being the reason for its adoption. Curious enough it is a provision that has since remained a feature of European brake vans. The cylinders were placed beneath the smoke box and worked inside cranks on the rear pair of drivers.

The tender was of the most primitive construction. It was mounted on four wheels, with springs on the axle boxes. A hole in the roof afforded the means of filling the tank with water. It is curious to note the roof over the tender, thus sheltering the coal and water while the enginemen were exposed to all the inclemencies of the weather. It will also be noticed that the convenience of manipulation had not been studied; the footplate was small and, with two men upon it, must have been greatly crowded. The heavy partition across the front of the tender, with the small opening at the bottom, must have been the cause of considerable climbing to and fro in order to keep a convenient supply of fuel at the opening. And yet, with all the crudities of design, that are so apparent to the modern eye, the engine ran, performing satisfactory service, for thirty-three years.

The second of the series (No. 2) is a four-wheeled engine built in England in 1834 by Mather, Dixon & Company, for the Petersburg Railroad. The illustration was made from a drawing obtained from one of the descendants of the firm of builders.

Data in regard to the details of the construction of this engine are lacking beyond the mere fact of the date of its construction and the road upon which it ran. It will be seen that like the "John Bull" it had no cab, but was provided with a railing by which protection was afforded to the men when moving over any portion of the machine. A change was also made in the position of the cylinders in that they were moved to the outside of the smokebox, while the connecting rod drove a crank on the outer end of the driving axle, and outside of the driving boxes that worked in a pedestal bolted to the bottom of the frames. The wheel arrangement with a single pair of drivers and a single pair of carrying wheels in front is one that was somewhat extensively used in England but received comparatively few applications in this country.

No. 3, the "Rocket," was also an engine of English construction and was brought to this country in 1839 for service on the Philadelphia and Reading Railroad. It was really a counterpart of the "John Bull" that had been sent to this country seven years before. There was the same arrangement of carrying wheels; the cylinders were located in the same place beneath the smoke box and the valves were driven by the same type of valve gear. The cylinders were, however, a



No. 1.—THE "JOHN BULL," BUILT BY GEORGE AND ROBERT STEPHENSON IN 1831.

little smaller than those of the "John Bull," having a diameter of 9 inches and a stroke of 18 inches. While there was no variation in the type and but few changes in the details of construction it does not follow that designers had been idle during these early years. There were so many problems to solve in order to secure a satisfactory working of the machine that changes of design received but scant attention. It will, however, be noticed that the foot-plate of the engine is protected by a railing and there were a few additional conveniences on the engine. The clumsy and bulky pilot, which was an American addition to the engine "John Bull," was not added to the "Rocket." The engine was designed and built for general traffic and was so used for many years, after which it was used for light switching on the wharves.

The drawings now skip over a period of eleven years, during which time the importation of locomotives from England had almost entirely ceased and American builders were not only supplying the demands of the home market, but were stamping their output with the marks of their own individuality and were gradually evolving what has since become known as the American type of locomotive. This type, however, was not the result of a continuous and unbroken series; each member represented a step towards the final type; but there were many experiments carried to a more or less successful issue, that naturally varied somewhat from the line of direct descent. Among the designs that helped to establish the type may be mentioned the "Lightning" (No. 4).

This engine was built in 1849 by Edward S. Norris at the Norris Locomotive Works, when these were located at Schenectady, New York, for the Utica and Schenectady Railroad. It had cylinders 16 inches in diameter with a piston stroke of 22 inches. The wheels of the forward truck were 3 feet 6 inches in diameter and the trailing wheels had a diameter of 4 feet 6 inches. The boiler was 3 feet 6 inches in diameter, and contained one hundred and sixteen 2-inch tubes which were 10 feet 3 inches long. The firebox measured 54 inches by 36 inches. The engine weighed twenty tons.

The boiler of this engine was too small to make steam, the cylinders were not large enough for the driving-wheels, and the wheels had not weight enough for adhesion, so that consequently the engine was not successful. It will readily be seen that without sufficient steam generating capacity, tractive force, or adhesion that a locomotive must be a very inefficient machine. It will be seen that even at this early date it had a stationary link-motion for its valve gear. A comparison with an illustration of one of Crampton's locomotives, published in Clark's Railway Machinery, will show that they closely resemble each other, and probably the Norris design was suggested by Crampton's engines. The system of locating the driving-axle behind the fire-box, with some minor novelties, formed the subject of a patent granted to Crampton in 1843. The English engines, however, had all of the wheels rigidly attached in the frames, whereas it will be seen that the front wheels of the Norris engine were in a truck or "bogie."

Strange as this engine appears as compared with the modern passenger locomotive of the American type, it still possesses some strong points of resemblance. It was carried on eight wheels, the two front pairs of which were set in a bogie truck; the two rear pairs formed a rigid wheel base, and it only remained to couple them together with a side-rod to have a full-fledged outline of the American type. The cab, however, is wanting, but the pilot appears in embryo in the wheel guard at the front. It is also to be noted that even at the date of the construction of this engine the cylinders were given a diameter that remained practically at the upper limit for twenty-five years, though the stroke was slightly increased during the next quarter of a century. The fruitlessness of using cylinders of this size with such a small boiler will be at once apparent to the modern engineer.

By 1850, however, the American type of engine had assumed its definite form, so far as the arrangement of the wheels was concerned. The four-wheeled bogie truck had been definitely accepted as the best method of carrying the front end of the engine and, except in details of its construction, has held its own for the past fifty years. The cylinders, however, had not been definitely located outside the frames. Spasmodic attempts to do so had been made, as illustrated by Nos. 2 and 4, but the outside frame apparently rendered it quite impossible to obtain a secure fastening for the cylinders, and so they were placed beneath the smoke box, as in the "John Bull" engine, necessitating the use of a crank axle. The typical American engine for the decade extending from 1850 to 1860 is shown in No. 5, though it is a better representation of current design at the earlier than the latter date.

The arrangement of cylinders was not a popular one, and, even in 1850, attempts were made to increase the accessibility of the parts by inclining the valves sidewise so that they were readily accessible, an improvement over previous constructions where they were below and beneath the frames. The hook motion, too, had been improved by the addition of an independent cut-off valve.

The design shows another step forward in the development of the cab. In the "John Bull" there was no protection about the foot-plate; then came the open railing of the "Rocket" and "Lightning" to be followed by one more step in advance, consisting of the filling in of the open space and thus forming some slight protection against the weather.

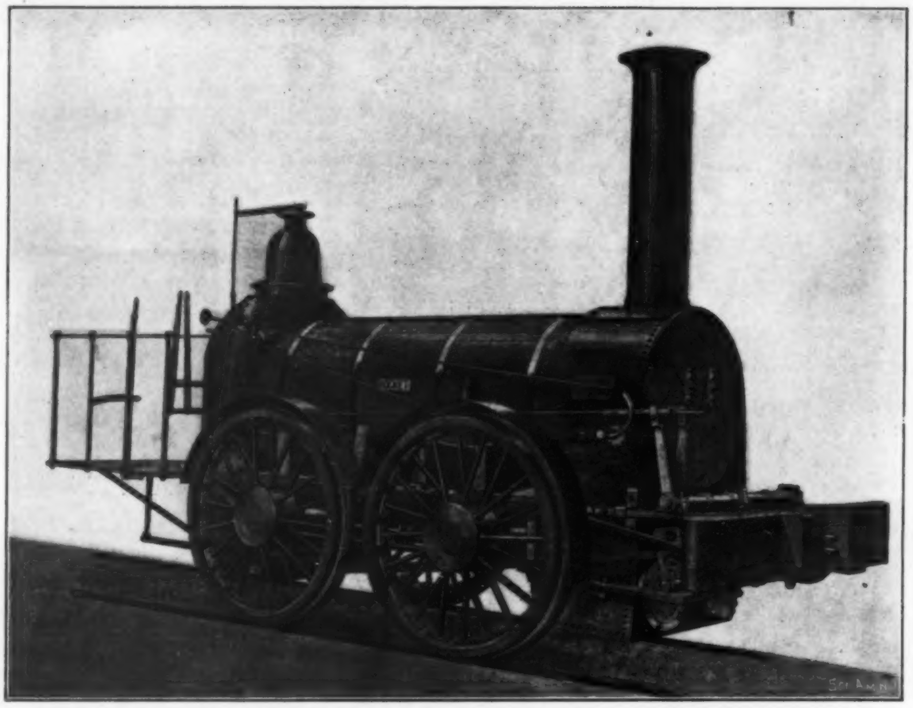
The firebox was small and round, and was set down between the driving axles. It was surmounted by a large hemispherical dome formed of small sheets, which was in turn capped by a small dome. The large flaring stack that has since remained a characteristic feature of American wood-burning engines had been developed and was destined to hold its own until that class of fuel was abandoned.

The headlight that had previously been used did not appear in this design. The equalizers had, however, been introduced, and was located beneath the upper bar of the frames. The pilot, too, had assumed the definite form which it has since retained as a characteristic feature of the American engine.

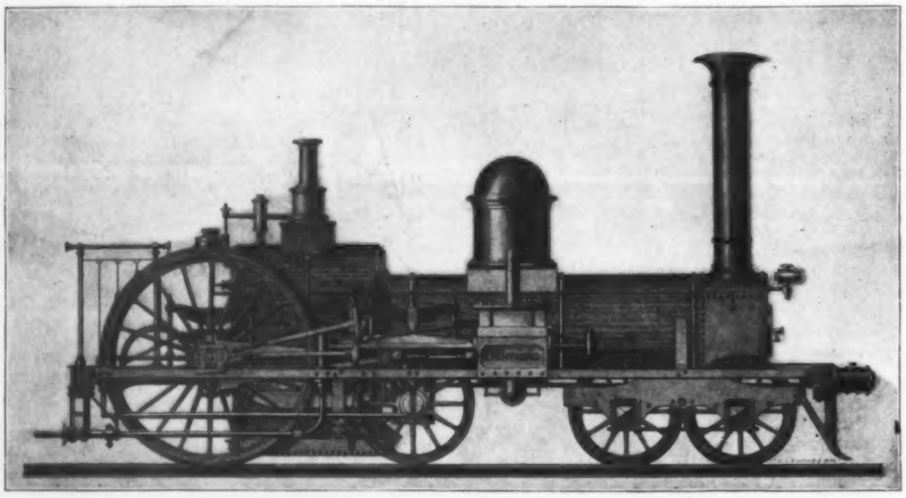
This engine represents the results of the development of two decades of locomotive designing in the United States. There was the pilot, the bar frame, the bogie truck and the four wheels coupled that have formed a combination of such excellence that they seem destined to hold their own for a long time to come.

While the eight-wheeled locomotive was in process of development, experiments were made with other arrangements of wheels. In 1852 there was built a ten-wheeled locomotive (No. 6). The engine, however, really represents a type of locomotive that first appeared about 1846 and was used where a greater tractive force than it was thought possible to obtain with four driving wheels, was desired. In this construction some of the peculiarities of the American locomotive have been very fully developed.

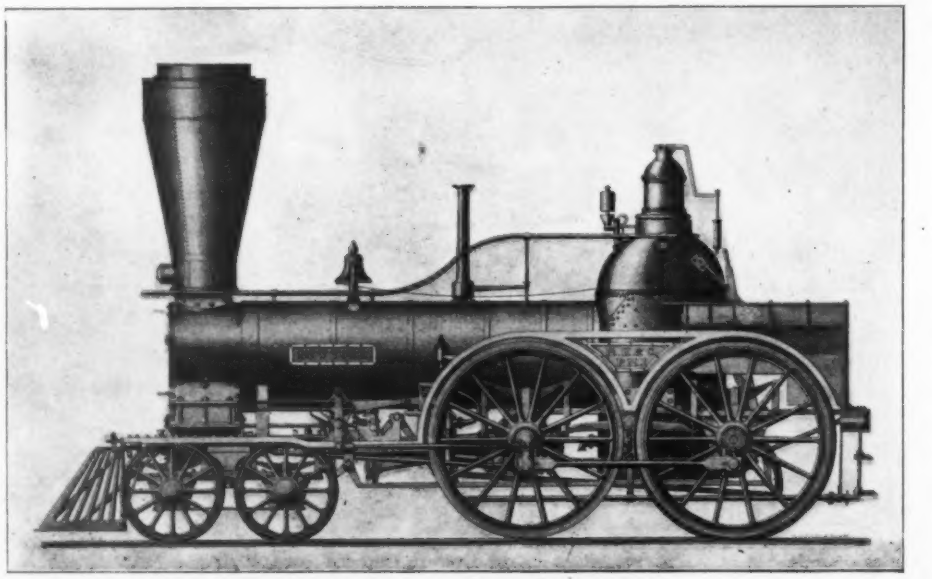
The cab, however, in all of the completeness shown in the engravings, was not a part of the original engine,



No. 3.—THE "ROCKET," BUILT FOR THE PHILADELPHIA AND READING RAILROAD IN 1839.



No. 4.—THE "LIGHTNING," BUILT BY THE NORRIS LOCOMOTIVE WORKS, IN 1849, FOR THE UTICA AND SCHENECTADY RAILROAD.

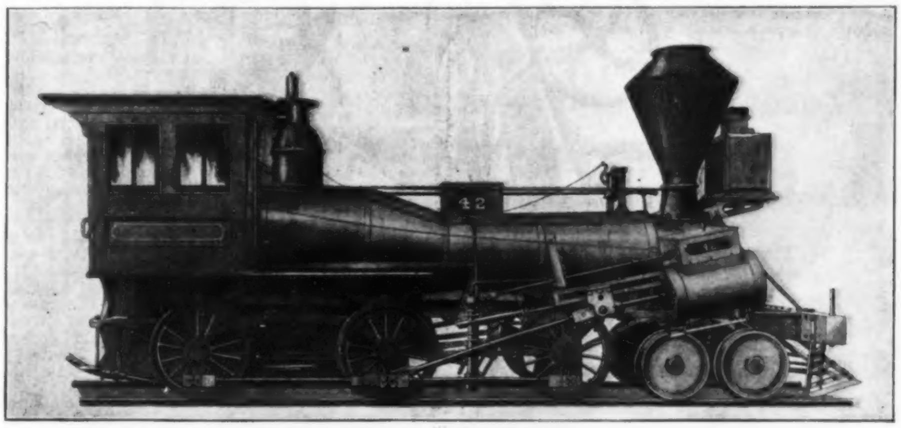


No. 5.—TYPICAL AMERICAN ENGINE, 1850.

but was a later addition. In its original form it partook more of the nature of a shield in front of the engine men.

The use of the bogie truck at the front end led to an elevation of the cylinders, which were accordingly inclined in order to place the guides and their own center in a line with the axis of the main driving axle. The guides were of the two-bar type with a crosshead of what was afterwards known as the Laird type. In this engine we find that the pilot had been introduced and developed until it had reached practically the same form that we have to-day.

The headlight was used, and the link-motion had been adopted as the means of working the valves. The large conical smokestack was used on wood-burning engines for a great many years, and only disappeared with the adoption of coal as a fuel. The cylinders of



No. 6.—TEN WHEELED LOCOMOTIVE BUILT IN 1852.

these engines were 16 inches in diameter with a piston stroke of 24 inches, a stroke that was practically the standard for all American engines until 1895 or 1896.

(To be continued.)

THE SIBERIAN RAILWAY.

MR. KHILKOFF, Minister of Ways and Communications, had a special train sent to him on the Great Siberian Railway some months ago, says R. T. Greener, Commercial Agent at Vladivostock. There were five coaches—one first-class, two secondclass, one dining, and one baggage car. All the appointments were excellent. There were besides the usual library, pianos, writing conveniences (found in American cars), a barber shop, a gymnasium, a good supply of ice, patent water boilers, dials which indicate the next station and the length of stop, double windows to protect from dust and the extreme Siberian cold; and an observation car at the rear. On this train were attendants speaking English, French, and German. The cars are lighted throughout by electricity. There is no charge for the barber or for medical attendance. The bath costs 2 rubles ($1). From St. Petersburg to Irkutsk the transit occupies about seven days; from Moscow, about six; and from Paris, not more than twenty-eight days.

The total length of the line to Vladivostock will be 4,714 miles. The cost will be $400,000,000.

The section just completed as far as Stretinsk is important, because it marks the connection with Vladivostock, some 1,500 miles, and gives a continuous all-rail travel of over 5,000 miles from Moscow. As is well known, there will no longer be any necessity for skirting the Amur, by railway, since the acquisition of transit rights in Manchuria gives an almost straight line from Stretinsk, via Tsitsikar, Harbin, Nikolsk, then south a three hours' ride to Vladivostock. The last rail on the Moscow-Stretinsk division was laid December 28, 1899.

Lake Baikal is as long as England, covers an area of 12,430 square miles, and is the formidable obstacle to be overcome. It is 1,561 feet above sea level, has a shore line of nearly 1,200 miles, a depth varying not less than 819 feet on an avarage, and a distinct ebb and flow. Four thousand five hundred feet have been sounded, and in one instance 4,900 feet is the record.

After crossing Lake Baikal—by rails over the ice in winter, by boat in summer—the road assends the Yablonoi Mountains and attains its loftiest elevation, 3,412 feet above sea level. From this point it desends to the Amur.

As at present planned, there will be three branches, all via Harbin; to Nikolsk, Vladivostock; to Pekin, via Mukden and Niuchwang; and to a point not yet given out. The Nikolsk-Harbin branch is rapidly going forward from the Niboisk terminus, and that to Mukden is now complete.

Two travelers, who have made the overland journey, arriving at Vladivostock within a week, were six weeks from Moscow, including a stop-over of nine days. About the food, there are varying reports. Some say even at remote stations the restaurants are excellent, with substantial dinners at 50 cents; others say the charges are extravagant. It depends much, I imagine, on the philosophy and patience of the traveler. My own experience on the Ussuri branch to Khabarofsk is good food, reasonable prices, and every attention. The entire road is divided into sections of two-thirds of a mile each. At each station is the cottage where the station master lives with his family and the guards. Between the Urals and Tomsk, there are said to be nearly 4,000 of these guards. When travelers speak in a critical manner of the number of "soldiers" found on the cars and along the road, it is to be remembered that it is the same as if our conductors, brakemen, flag and switch men all wore the same uniform.

Word has just been received that the administration of the Central Siberian Railroad intends to do some good work in shaping up the line and increasing the speed according to plans fully matured. The cost of this work will be about 55,000,000 rubles ($28,325,000), and the varied improvements will require seven years.

From Ob to Irkutsk, 1,754 versts (1,163 miles), the following programme will be carried out: (1) All the rails will be changed; (2) all wooden bridges will be replaced by iron ones; (3) stations and crossings will be widened; (4) several new crossings will be constructed; and (5) passenger accommodations will be provided, as well as houses for railroad employees, freight warehouses, provision stations for the army and also for immigrants.

GNOSTIC GOLD AMULET.

ACCORDING to the Journal der Goldschmiedekunst, a very interesting find for the history of art and civilization has of late been made in the burial grounds of the former Roman cohort camp "Gelduba," which was situated on the Nether Rhine where the village of Gellep now lies. It is a Gnostic gold amulet which dates back to about the third century A. C. and is probably the first find of its kind that has been made in the Rhine district. Similar finds are very rare, anyway, owing to the precious metal. According to an exhaustive statement, which M. Siebourg makes on the subject, the amulet consists of a gold capsule with three eyelets, containing a rolled plate of gold which was folded together, and was found to bear inscriptions in Greek characters. Together with the capsule a smaller amulet of gold was found that had likewise served as an ornament for the hair and had been placed in the grave with the dead body. Special interest deserves the contents of the leaflet. The latter had been sent in vain to Munich, Berlin, and London for deciphering purposes when Sieburg recognized the inscription to consist of names of gods, in Greek characters, while no verb or sentence betrays the real purpose of the amulet. First the planet records of Babylonia are enumerated. From the Hebrews, the name "Jahwe" occurs, and the remainder of the names point to the dieties of Egypt, the classic country of magic and of syncretism. The use of Greek letters makes it probable that the amulet originates from Egypt where the religions of the Orient converged, and the black art of magic was flourishing. The amulet may have been carried to the vicinity of the lower Rhine by a Roman soldier or itinerant trader, who are known to have been the pioneers of ancient civilization everywhere, and it may have been acquired there by the wearer, who is to be assumed to have been a woman rather than a man. Since she had worn it in life for protection against danger, it was left on her in the grave. The described find must be regarded as important, because it bears additional evidence to the fact that the movement of the spirits known by the name of "Gnosis" and which especially in the third century, reached its culmination point, had advanced as far as the Rhine, a supposition, which was formerly only supported by one previous discovery, viz., the silver tablet of Badenweiler.

GAS COMPRESSORS ACTUATED BY WATER UNDER PRESSURE.

IN incandescent lighting with gas, the creation of very powerful sources capable of competing with voltaic arc lamps gives rise to very interesting researches.

Some inventors have recourse to the compression of the gas, others to that of the air, which they send into the burners at the same time that the gas reaches them at the ordinary pressure of from 20 to 60 mm., while others, again, increase the consumption of the gas and effects its intimate mixture with the air through mechanical means.

The fact is admitted that the most powerful sources are obtained through the compression of either the gas or the air. Compression might even be applied to both fluids were it not for complications that it has been impossible to avoid in the apparatus, up to the present. Such compression can be obtained in many ways. When it is a question of lighting large industrial establishments, that have a motive power at their disposal, nothing is simpler than the mechanical control of an air compressor; but, with small installations that employ but five lamps, on an average, it will be readily seen that the question does not present itself with the same character of simplicity. It is to water under pressure taken from the city mains that recourse is had for actuating the compressor and storing up in a reservoir the air and gas or the mixture thereof at a pressure that varies, but that is always greater than 0·4 of an atmosphere.

At the inception of the exploitation of the systems of intensive lighting with slightly compressed gas, numerous difficulties were created by the compressors. The stuffing boxes and the piston packing, as well as the gas pockets, had not, despite the care exercised in their maintenance, sufficient tightness to prevent leakages.

It became necessary to arrange upon the passage of the gas, between the source of supply and the compressor, on the one hand, and between the latter and the burners, on the other, a certain number of regulators to permit the jumping of the flame produced at every stroke of the piston. Besides, it was possible for the apparatus adopted to operate only with a relatively high water pressure, which was not always to be had. So the water companies were loathe to have connected with their mains apparatus of which one of the least inconveniences was their great consumption of water.

Some comparative experiments with different systems of compressors were undertaken in England by the Somzée-Greyson Company, in which the most favorable results were furnished by the Keith apparatus, which, in all the installations of intensive lighting of this company, has, by degrees, subsequently replaced the old compressors.

Of the two models represented herewith, on a scale of about one-fifth, the first is capable of furnishing from 100 to 150 cubic feet of compressed gas an hour and the other from 390 to 495, according to the pressure at which the water is employed.

In the compressor and gasometer combined, the compressor is nothing more than a double acting pump consisting of a cylinder provided at its upper part with a dismountable head and fixed upon a base along with a cylinder placed within the interior of and concentric with the first.

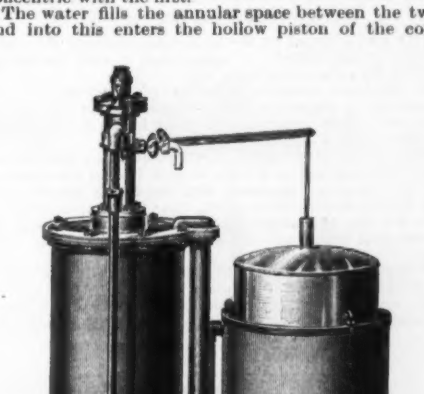
The water fills the annular space between the two, and into this enters the hollow piston of the compressor. Two internal pipes ascend from a box with four valves fixed under the base and connected directly with the gas piping. One of the pipes debouches in the interior of the piston, near its summit, and the other terminates near the top of the outside cylinder, with which it communicates.

Two of the valves of the four above mentioned serve for the admission of the gas and the two others for the forcing of it into the holder of the gasometer. The lower part of the holder is provided with a rim of lead, the weight of which is so calculated as to give the gas the desired pressure, while its upper part is connected with the lever of a cock placed upon the conduit of water under pressure that supplies a hydraulic motor, the starting and stopping of which are controlled by the up and down motions of the gas

A, gas inlet; *B*, exit of the compressed gas.

FIG. 1.—KEITH GAS COMPRESSOR.

(SMALL SIZE.)



A, gas inlet; *B*, exit of the compressed gas; *C*, clearance plug.

FIG. 2.—KEITH GAS COMPRESSOR.

(LARGE SIZE.)

holder, which vary according to the consumption of the gas.

The motor consists of a cylinder established upon the center of the base and provided with a long, hollow piston of which the rod is fixed to the dome of the hollow piston of the compressor. It is provided with two distributers, a main one with two unequal pistons and an auxiliary one, the rod of which freely traverses the long, hollow piston of the motor. At the ends of its stroke, this last-mentioned piston meets with a tappet connected with this rod and displaces the auxilliary distributer.

The valve box is so partitioned as to assure the double action of the hollow piston of the compressor. When the piston of the motor is at the lower end of its stroke, the water under pressure exerts a preponderant action upon one of the distributers, which descends and exposes the orifices through which the water flows beneath the piston of the motor. As the lower surface of this piston is wider than its upper one, the piston ascends and carries along in its motion the hollow piston of the compressor, which sucks in gas through a valve and pipe provided for the purpose. At the same time, this piston forces through one of the four valves above mentioned the gas that has been admitted beneath it and sends it into the gasometer through a vertical conduit.

After the hollow piston of the compressor has nearly reached the end of its stroke, the piston of the motor raises one of the distributers, which puts the chambers of the auxilliary distributers in communication. The water under pressure flows beneath the principal distributer, which rises by virtue of the greater width of its lower surface. As the spent water is then under the piston of the motor, it escapes through orifies formed for the purpose into the concentric cylinder of the compressor, the piston of which descends with one of the distributers.

During the descent of the hollow piston of the compressor, the gas that it has sucked in is forced through a conduit and one of the valves, while a new supply of gas is sucked into the top of the cylinder through another of the valves.

The residuary water sent into the internal cylinder overflows into the annular space in which the piston of the compressor works and enters the tank of the gasometer so as to maintain a hydraulic joint therein.

The compressor with an independent gasometer is adapted for installations of some importance. In this apparatus the double acting pump is analogous to that of the preceding and its piston is actuated in the same manner, by a hydraulic motor, which here is arranged at the upper part of the cylinder of the compressor.

The operation of these Keith compressors is silent, and they constitute automatic regulators that assure great steadiness in the light. As there is no stuffing box on the exterior, chances of leakage are avoided and no odor is disengaged. These apparatus can therefore be installed in any place that may be convenient. They are also adapted for use with the most variable pressures, and, if need be, they can be made to operate under the charge of the column of water furnished by a dwelling house.

For the above particulars and the illustrations, we are indebted to the Revue Industrielle.

THE DISMOUNTABLE GUN OF THE STATE OF CONGO.

THE gun adopted by the Independent State of Congo is made dismountable, in order that it may be easily carried by men or animals.

It lightness permits likewise of carrying it, all mounted, by wagon or boat. It can also be hauled by one man, while two men can easily follow a column of infantry with it.

When it is carried by men, three persons are necessary for the gun, two for the wheels, two for the cheeks, one for the pointing screw and duplicate pieces, and one for the equipments, stock, etc.; total, nine men.

As for the cartridges, they are inclosed in tens in aluminium boxes, each of which forms a load for one man.

The gun is carried in a leather case, while the other objects are inclosed in tarpulin bags.

In carriage by horse or mule-back, three animals are necessary, one of which is loaded with the gun, another with the carriage without the wheels, and the last with the wheels and a box of ammunition.

The mounting and dismounting of the gun are effected very rapidly, and in three or four minutes, according to the skill of the gun squad.

The Société Cockerill, of Belgium, which constructed this material and had it adopted by the State of Congo, after some very satisfactory official tests upon the Liege proving grounds, is convinced of the great future in store for it, not only in foreign countries in which communicating roads and beasts of burden do not always exist, but also in Europe, as a cavalry or mountain piece.

This gun, in fact, by reason of its solidity, lightness and simplicity, lends itself to all the exigencies of war.

The piece is of 1·85 inch caliber and wholly of Martin-Siemens steel. The breech is closed by a screw. All the parts of the carriage are of forged or cast steel.

The ammunition consists of ordinary shells or ball shells. The powder employed is black powder or cordite.

The following are the principal data concerning this gun:

GUN AND CARRIAGE.

Caliber	1·85	inch.
Length of chamber in caliber	·95	"
Length of chamber in inches	44	"
Total length	44	"
Number of grooves	20	
Width	0·2	"
Depth	0·12	"
Angle of torsion of grooves	3° to 6°	
Distance to muzzle; uniform pitch.	10·4	inches.
Weight of gun without closure	176	pounds.
Weight of closure	14·3	"
Weight of carriage	323·4	"
Weight of gun and carriage	514·8	"
Diameter of wheels	39	inches.
Gauge	27·3	"
Height of line of sight above ground	29·8	"
Height of center of gun	26·3	"
Upward pointing allowed by the carriage	7° + 15°	

AMMUNITION.

Weight of the charge of black powder of 1·5 to 3·1 inches	7¾	pounds.
Weight of the charge of smokeless powder	3¼	pounds.
Ordinary shell; length	6·85	inches.
Ordinary shell; weight complete	3·3	pounds.
Bursting charge; weight	·13	"
Ball case; length	7·6	inches.
Ball case; weight	4·4	pounds.
Ball case; number of balls	114	
Length of complete cartridge	11·9	inches.
Weight of complete cartridge with ordinary shell	4·5	pounds.
Weight of complete cartridge with ball case	5·6	pounds.
Weight of ammunition box, empty	11·1	"
Weight of ammunition box, with 10 ordinary shell cartridges	56·8	"

DISTRIBUTION OF THE WEIGHT TO BE CARRIED BY MEN.

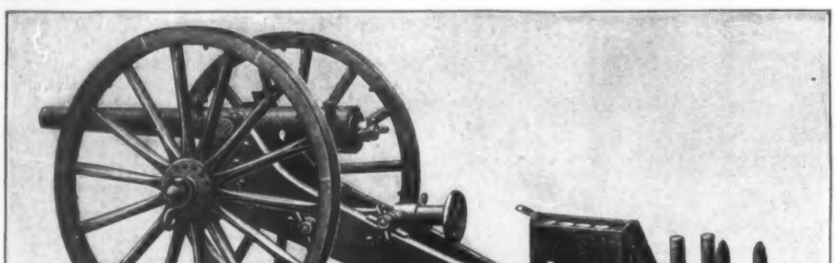
Gun, with closure		190·3	pounds.
Two cheeks, each		57·2	"
Axle	41·8 pounds	59·4	"
Trail and lever	17·6 "		
Pointing apparatus	44 "	61·6	"
Duplicate pieces and tools	17·6 "		
Two wheels, each		52·8	"

BALLISTIC DATA.

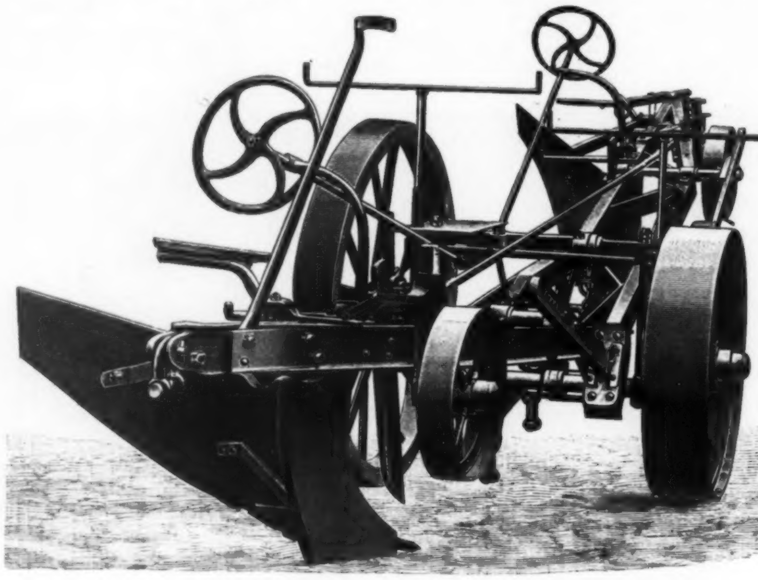
Initial velocity with black powder of 1·55 to 3·1 inches	1,213·6	feet.
Initial velocity with smokeless powder	1,344·8	"
Live force at the muzzle; black powder	80,040	foot pounds.
Live force at the muzzle; smokeless powder	93,235	" "
Pressure with black powder	1,100	atmospheres.
Pressure with smokeless powder	1,150	"

As the material can be transported, mounted or dismounted, it is capable of passing everywhere and of following the infantry or the cavalry, and it will be possible to station it at points that neither field nor mountain artillery could occupy.

For the above particulars and the illustrations we are indebted to La Nature.



DISMOUNTABLE GUN OF THE STATE OF CONGO.



A STEAM PLOW FOR TRENCH DIGGING.

STEAM-PLOW FOR MILITARY PURPOSES.

ONE of the latest military inventions which has attracted the attention of army officials is a steam-plow, which in one hour can dig a four foot trench three miles in length. The body of the machine comprises a strong horizontal frame formed with an angle of 95° and supported at the angle by two large iron wheels. At each end a plowshare is mounted, provided at its front end with a steel point. The shares are so arranged that the earth can be thrown to the right or to the left as desired. The steel point breaks clods of earth which may lie in its path. The machine is merely an ordinary Fowler steam-plow modified to meet the requirements of military service. It is said that in the Transvaal the plow has been successfully used in digging rifle pits; but whether the report be true can not be ascertained. From the military standpoint, the contrivance is clearly defective in so far as there are no means for protecting the men who must guide it.

HOT WATER FOR A WHOLE TOWN.

IN Delaware, O., light, heat and power are to be supplied to the town from one central station. The Delaware Electric Light and Power Company's plant will shortly afford all this. This system was inaugurated by Edward F. Gwynn, an electrician, whose franchise embraces every right and privilege to all highways for the complete construction of a hot water system of heating, to be utilized in any locality. The era of stoves and furnaces is about to pass into history there, and every citizen will be supplied with heat at no greater expense than that paid for coal or wood. The hot water is supplied through a maze of pipes and radiators, and finally returns to the central station to be reheated, and again started on its warmth-giving journey.

In all manufacturing nowadays, the utilization of

by-products, hitherto thrown away, marks a distinct advance. In the making of electricity, either for light or power, where the current is produced from dynamos driven by steam engines, there results a large amount of waste steam—the exhaust steam which is usually thrown away. This steam still contains more than three-quarters of the heat originally imparted to it by the coal burned under the boilers. In this hot water system for the entire town, the greatest by-product of the electric light and power business becomes a source of great income. The steam is first used in the engines, after which it passes as exhaust through a feed water heater, which heats the fresh supply of boiler water. The feed water absorbs only about 10 per cent. of the exhaust steam, the remainder being then passed to a large steel heater of small tubes, surrounded by water.

RAILS AND RAIL JOINTS.

OF the vast number of rails in use throughout the world, there are four well-defined types: strap, bridge, chair and flat-foot T-rails. The strap-rail is not used on modern steam railways; but slightly modified it is found now and then on horse-car lines. The bridge-rail (Fig. 1) is a development of the strap-rail, and is sometimes called the "Brunel" rail after its inventor. In this rail a greater height and more substantial base than in the strap-rail is secured by bending the side members at right angles.

Radically different from either of these two rails is the chair-rail (Figs. 2 and 3), which has either a bull-head or a typical T-rail head. Chair-rails are so called after the "chairs" used to secure them to the sleepers.

The rails are sometimes formed with two heads, so as to make the utmost use of the rail by bringing the lower head uppermost after the upper head has been worn away. But since cast steel is the material of which rails are now made, the economical reasons which led to the adoption of double-headed chair-rail no longer obtain; and in its stead the flat-foot rail (Figs. 4 and 5), of approximately T-section, is now largely used.

The flat-foot rail was devised by the famous American inventor Stevens in 1832 and was later introduced in Europe by Vignoles, whose name it bears abroad. The flat-foot rail is essentially a double-headed chair-rail, with the lower head widened into a broad, smooth bearing-surface by which it is secured to the sleepers. The ideal form of a flat-foot rail would have a tall, thin web, with the broadest possible base consistent with flanges of small thickness. Experience has shown that this theoretical rail can never be realized.

It is impossible to state whether the chair or flat-foot rail is the more serviceable. Each has its disadvantages and its advantages. Both are used in almost every country in the world. The cost of the chair-rail is appreciably increased by the chair; but, on the other hand, this chair enables old rails to be readily removed and others substituted and offers great resistance to lateral pressure. The rail is very firmly held in place by the key used in connection with the chair. The flat-foot rail is directly secured by spikes driven into the wooden sleeper, with the result that the flanges often loosen, especially after the rails have been renewed several times. The reversing of the chair-rail has little to commend it. The unused lower head by reason of the pressure often loses its shape, so that when turned uppermost the cars will not run with their customary smoothness. The worn upper head, moreover, cannot be seated in the chair with the rigidity and firmness desired. Lastly, chair-rails which have been reversed often break. As we have already remarked, the general use of cast steel has rendered the reversing of chair-rails unnecessary. But in France and England they are still used on many roads.

Up to 1870 rails were made largely of wrought iron. Here and there costly crucible steel rails were employed. More often puddle-steel rails made of welded and rolled steel plates were met with. But the Bessemer cast and rolled rail has supplanted all these types. In order still further to reduce the cost of manufacture and of maintenance, rails were invented, the partially worn portions of which could be removed and new portions substituted. The best known rails of this type are of the compound form, commonly used in America about 1840, and soon after introduced into Germany. The compound rail was so constructed that whenever the head was unduly worn away, it could be removed and another substituted. With this end in view, the rail was made in sections as shown in Figs. 6, 7, 8, and 9. This sectional construction of the rail permitted the use of highly resistant metal for the heads. The complicated structure of these rails coupled with their great weight has prevented their general adoption.

The rail-bed is composed of stone, wood, or iron. Stone is the oldest material ever employed. Even to this day it is found in certain treeless districts where the cost of wooden sleepers is prohibitive. Perhaps the oldest stone sleepers in use are to be found on the Bavarian governmental road and on the Taunus Railway. On both these lines the old stone sleepers are gradually giving away to modern wooden ties.

Wood, either in the form of horizontal or tranverse sleepers, constitutes the most widely used form of road-bed. Longitudinal sleepers might be employed for strap, bridge, chair, and flat-foot rails, but not very successfully. The longitudinal sleeper is difficult to handle, is liable to shift, prevents proper drainage of the roadbed, and finally requires the use of tie-rods to maintain the gage of the track.

Metal roadbeds are gradually coming into more general use. The pot-sleeper type invented by Greaves was a form of metallic substructure formerly in extensive use. The sleeper, as shown in Fig. 10, resembles in form an inverted bowl upon which a chair is cast to receive the rail. Through two openings in the upper surface ballast can be packed into the interior. The pot-sleeper proved its efficiency in tropical countries, in regions where wooden sleepers rapidly decayed. The pot-sleeper can be employed only on railways with light traffic and comparatively small loads.

Rail and sleeper, constituting as they do the elements of a track, must be rigidly joined. Different methods of fastening the parts together have been used for this purpose in chair and flat-foot rails. In the former, chairs are used, consisting of strong iron blocks with upwardly projecting cheeks and reinforcing ribs. The form and arrangements of these parts are shown in Fig. 11. The rail rests on the concave bottom of the chair and against the outer cheek, and is held in place by a wooden key driven between the web and the inner cheek. Two holes are provided in the base of the chair-block for the purpose of bolting the rail to the sleeper. In the earliest form of chairs, iron keys and wooden pins or spikes were used. The wooden spikes were of little service, even though broad-headed iron wedges were driven into them for the purpose of providing additional security. Later, one or two oppositely driven keys were used which, during rainy weather, often swelled and expanded with such force that the chair was burst asunder. Sometimes the keys shrunk in the heat of the sun so that they failed to hold the rail in place. It was not until it was discovered that pressure and boiling in oil would enable the keys to withstand moisture and heat that chair-rails proved truly successful. Iron spikes or bolts soon superseded the old wooden spikes.

To secure the rails to the sleepers, wooden screws were originally employed, which were soon supplanted by spikes and screw bolts. At first the spikes were driven through holes bored in the flange of the rail, whereby the foot of the rail was considerably weakened. The introduction of hooked spikes and tie plates was a great onward step. Tie plates are excellent means for reinforcing the clamping action of the spikes; for when the rail is subjected to the strain of a passing train, all the spikes about a joint are affected in common. Moreover, tie plates prevent the embedding of the flanges in the wood of the sleepers.

Rails expand with heat and contract with cold. In constructing a track, due allowance must be made for this expansion and contraction; for this reason the rails are not made to abut one against the other, but are slightly spaced apart. The method of uniting the rails at the joints has received the attention of many an inventor. But in spite of the many patents which have been taken out, rail-joints can still be much improved. At first the ends of the rails were mitered and then fitted in place; or else they were scarfed together. But the results were not very gratifying; for the ends were worn away even more rapidly than in the case of butt joints. The first good joint ever constructed comprised a tie plate provided with flanges and holes, with spikes or bolts passing through the base flanges of the rail, and through the plate to hold the parts in place.

In the more recent types of rail-joints, fish-plates are used. Fish-plates are long, narrow plates of iron or steel fitting against the web between the lower edge of the head and the base flange, and bridging the slight space between the rail ends, so that the head is enabled to resist lateral pressure. Fish plates are fitted both to the inner and outer sides of the rails, and are bolted together.

Owing to the vibration produced by passing trains, the nuts of fish-plate bolts often work loose. In order to prevent their loosening, two nuts have been employed screwing on threads running in the same or opposite directions. In Hohenegger's nut-lock a thin, square metal plate notched at one side is placed between the nut and the corresponding fish-plate. With a chisel or other suitable tool, the upper half of the notched side is lifted up into engagement with the corresponding side of the nut, as shown in Fig. 15, so that the nut cannot turn without rotating the metallic plate. But since the lower edge of the plate rests upon the base flange, rotation is impossible.

An English inventor, Dering, proposed the use of spring fish-plates, firmly engaging the head, web, and flange of the rail and maintaining their position by reason of their elasticity. Hensinger von Waldegg recommended rivets of soft iron instead of bolts. In one of the older forms of joints three instead of four bolts were used, two being placed at the side and one in the center, passing directly through the gap between the rail ends. Still other forms of rail joints employ angle plates of the type illustrated in Figs. 21 and 22. Sometimes the outer plate is lengthened so as to extend upwardly flush with the head, thus to offer a greater bearing surface to the car-wheel (Fig. 19).

On American roads flat-foot rails are almost ex-

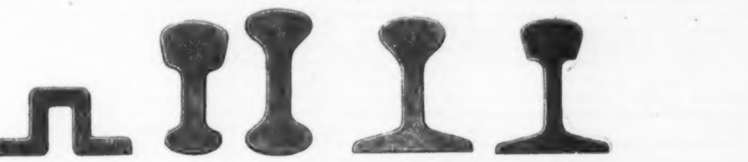
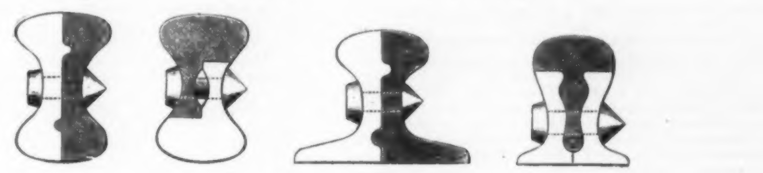


FIG. 1.—BRIDGE RAIL. FIGS. 2 AND 3.—CHAIR-RAILS. FIGS. 4 AND 5.—FLAT-FOOT RAILS.



FIGS. 6 TO 9.—COMPOUND RAILS.

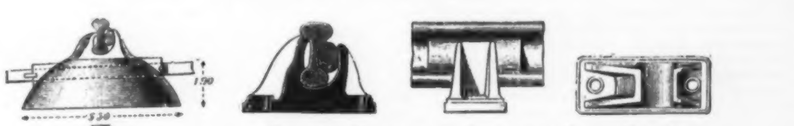


FIG. 11.—METHOD OF CLAMPING CHAIR-RAILS.

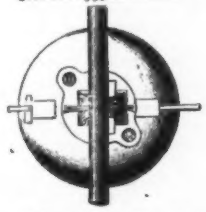


FIG. 10.—GREAVES' POT-SLEEPER.

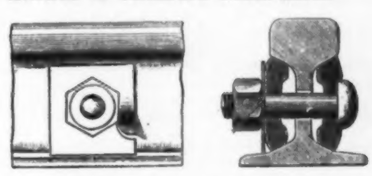
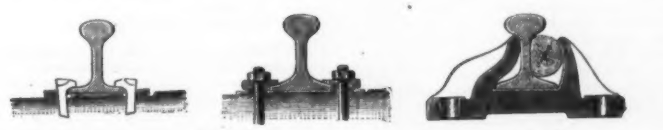
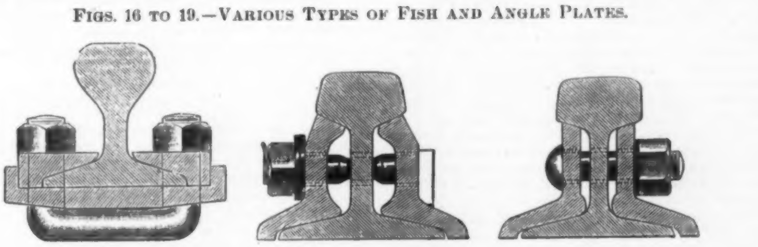


FIG. 15.—HOHENEGGER'S RAIL JOINT.



FIGS. 12 TO 14.—METHOD OF SECURING THE RAILS AT THE JOINTS.

FIGS. 16 TO 19.—VARIOUS TYPES OF FISH AND ANGLE PLATES.



FIGS. 20 TO 22.—AMERICAN RAIL JOINTS.

clusively used. The sections of these rails are all modifications of the letter T. The proportion of the different parts as well as the weights vary considerably.

There are many varieties of sleepers used in the United States. Wood is the material generally found, partly because it occurs in abundance, partly because it must be used in order to remedy the defects of a poor roadbed. All kinds of rail joints are employed, from the most primitive imaginable to the most ingenious that American inventors have been able to produce. Often the only connection between the rail ends is a plate, laid beneath the base. Sometimes even this plate is dispensed with and only the spikes serve to hold the rails in alinement. On most roadbeds angle-plates are used, the horizontal flanges of which are spiked down to prevent displacement.

Besides joints which employ plates to couple the heads, and webs, devices are also employed which merely couple the bases of adjacent rail-ends. In supported rails the tie plates are sometimes provided with two notches at both sides. Of the three tongues thus formed at each side, the central one is bent up, into engagement with the under surface of the head. The remaining tongues are spiked down in the usual manner. The opposite screw bolts which clamp the ground plate, the base flange of the rail, and the angle plate together in the Fisher joints have a common U-shaped shank extending beneath the base as illustrated in Fig. 20.

The spaces between the two rails, constituting the track are not in the same line as on German roads, but are so arranged that each joint will lie opposite the central portion of the opposing rail.

A TABLE OF ATOMIC WEIGHTS

OF SEVENTY-FOUR ELEMENTS.*

By Theodore William Richards.

Name.	Symbol.	Atomic weight.
Aluminium	Al	27·1
Antimony	Sb	120·0
Argon	A	39·9 ?
Arsenic	As	75·0
Barium	Ba	137·43
Beryllium	Be = Gl	9·1
Bismuth	Bi	208·0
Boron	B	10·95
Bromine	Br	79·955
Cadmium	Cd	112·3
Cæsium	Cs	132·9
Calcium	Ca	40·1
Carbon	C	12·001
Cerium	Ce	140·0
Chlorine	Cl	35·455
Chromium	Cr	52·14
Cobalt	Co	59·00
Columbium	Cb=Nb	94·0
Copper	Cu	63·60
"Didymium"	Nd+Pr	142 ±
Erbium	Er	166·0
Fluorine	F	19·05
Gadolinium ?	Gd	156·0?
Gallium	Ga	70·0
Germanium	Ge	72·5
Glucinum	Gl = Be	9·1
Gold	Au	197·3
Helium	He	4·0 ?
Hydrogen	H	1·0075
Indium	In	114·0
Iodine	I	126·85
Iridium	Ir	193·0
Iron	Fe	56·0
Lanthanum	La	138·5
Lead	Pb	206·92
Lithium	Li	7·03
Magnesium	Mg	24·36
Manganese	Mn	55·02
Mercury	Hg	200·0
Molybdenum	Mo	96·0
Neodymium	Nd	143·6
Nickel	Ni	58·70
Niobium	Nb=Cb	94·0
Nitrogen	N	14·045
Osmium	Os	190·8
Oxygen (standard)	O	16·000
Palladium	Pd	106·5
Phosphorus	P	31·0
Platinum	Pt	195·2
Potassium	K	39·140
Praseodymium	Pr	140·5
Rhodium	Rh	103·0
Rubidium	Rb	85·44
Ruthenium	Ru	101·7
Samarium ?	Sm	150·0
Scandium	Sc	44·0
Selenium	Se	79·2
Silicon	Si	28·4
Silver	Ag	107·930
Sodium	Na	23·050
Strontium	Sr	87·68
Sulphur	S	32·065
Tantalum	Ta	183·0
Tellurium	Te	127·5 ?
Terbium ?	Tb	160·0
Thallium	Tl	204·15
Thorium	Th	233·0
Thulium ?	Tu	170·0 ?
Tin	Sn	119·0
Titanium	Ti	48·17
Tungsten	W	184·4
Uranium	U	240·0
Vanadium	V	51·4
Ytterbium	Yb	173·0
Yttrium	Yt	89·0
Zinc	Zn	65·40
Zirconium	Zr	90·5

NOTE.

Since the appearance of this table in 1898, the Committee of the German Chemical Society (Messrs. Landolt, Ostwald, and Seubert) have made their interesting report upon the subject, and have invited the chemists of the world to join them in deciding upon one standard to be used everywhere. The fulfilment of this very desirable end must necessarily be a matter of many months; hence the present table is republished this year in accordance with the original plan. It is to be distinctly understood that the republication is not in any way an attempt to compete with or to forestall the International Committee; it is merely an expression of opinion, which may be of temporary service. The fact that none of the other recent tables follow the accepted scientific usage concerning significant figures seems to afford an additional reason for reprinting this one.

The investigations of the past year have pointed to a change in four values given in the table of 1898. Calcium is made 40·1, instead of 40; for recent experiments (as yet unpublished) in this laboratory indicate that last year's estimate was too low. Neo and praseodymium were oddly transposed by their discoverer, and the more accurate values of Jones (Am. Chem. Journ., 1898, xx., 345; Chemical News, lxxvii., 280) and others are substituted. Lastly, Denher's (Journ. Am. Chem. Soc., 1898, xx., 555; compare Clarke, Ibid., 1899, xxi., 200; Chemical News, lxxix., 195) careful investigation upon selenium seems to show that this element has a higher atomic weight than was formerly supposed to belong to it. For the present a compromise number, 79·2, is recorded above.—Proceedings of the American Academy of Arts and Sciences.

* Compiled in April, 1899, from the most recent data.

COMBINATION OF CARBON SULPHIDE WITH HYDROGEN AND NITROGEN UNDER THE ACTION OF THE ELECTRIC EFFLUVIUM.*

The experiments recorded in this paper relative to the combinations effected under the influence of the electric effluvium,† combinations of quite a special character, concur in determining the conditions of the reactions.

HYDROGEN.

1. Hydrogen .... 100 vol.
   Gaseous carbon sulphide .... 70 "

Coil worked by accumulators whose tension was 12·6 volts. Temperature, 24°.‡ Barometic pressure about 750 mm. Time of action, 5 hours.

The carbon sulphide disappeared entirely, that is 70 vol.; the volume of hydrogen absorbed being 36 vol. Ratio, 2:1·03.

2. Hydrogen .... 100 vol.
   Gaseous carbon sulphide .... 68 "

Coil worked by accumulators whose tension was 25 volts. Temperature, 24°. Time, 1 hour.

All the carbon sulphide disappeared. The volume of hydrogen absorbed was 34·3 vol.; that is, 2:1·01.

3. The same ratio was observed materially with the following mixture:

   Hydrogen .... 100 vol.
   Argon .... 81 "
   Gaseous carbon sulphide .... 133 "

Tension, 12·6 volts. Temperature, 21°. The gases disappeared.

   CS^2 .... 77 vol.
   H^2 .... 38 "
   Arg^2 .... 2 "

4. If the tension of the current is lowered to the point where it would cease to actuate the coil, the hydrogen is equally absorbed, but the proportion of carbon sulphide condensed is increased:

   Hydrogen .... 100 vol.
   Gaseous carbon sulphide .... 73 "

Tension, 42 volts. Temperature, 24°. Time, 16 hours. The gases disappeared.

   CS^2 .... 28 vol.
   H^2 .... 6 "

It will be noticed that nearly one-half the carbon sulphide remained.

Under the conditions of the preceding experiments a resinous product was formed, solid, yellow, and having an odor similar to mercaptan. This product is insoluble in ether. Carbon sulphide dissolves it in small quantity. Concentrated potassa attacks it cold without dissolving it entirely. The liquor obtained slightly blackens the paper of lead acetate, and gives rise, by the addition of chlorhydric acid in excess to a slight disengagement of sulphureted hydrogen.

According to these observations, the reaction of the effluvium or a mixture of hydrogen and carbon sulphide produces a compound corresponding to the formula $C^2H^2S^4$; which would represent either a persulphydric oxalic acid, or rather a persulphide derived from glycolic aldehyde (glyoxal).

$$C^2H^2O^2,$$
$$C^2H^2S^2;\ C^2H^2S^2 + S^2.\ ;$$

With a sufficient electric tension this compound is formed alone. But if the tension is too feable, the polymerization of the carbon sulphide proceeds more rapidly than its combination with the hydrogen.

Further on, we will recur to this polymerization of the sulphide.

NITROGEN.

1. Nitrogen .... 100 vol.
   Gaseous carbon sulphide .... 69 "

Temperature, 22°. Pressure, 754 mm. Tension of current acting on the coil, 12·6 volts.

All the carbon sulphide disappeared after six hours of action. Nitrogen absorbed, 16 vol. Ratio 4 CS^2 : Az^2.

2. Another experiment was made with the same relative volumes, a current of tension equal to 25 volts acting on the coil. Time, only 3 hours.

Half only of the carbon sulphide disappeared, the ratio between the gases condensed being 7 CS^2 : Az^2.

It seems, then, that the condensation of the carbon sulphide must have proceeded more quickly than its combination with the nitrogen under the latter conditions, as though, with the increase of the tension of the current feeding the coil, the tendency of the nitrogen to combine with the carbon sulphide were diminished. But this requires more thorough investigation.

ARGON.

1. Argon .... 100 vol.
   Gaseous carbon sulphide .... 70 "

Temperature, 23°. Tension of current, 6 volts. Time, 3 hours.

The carbon sulphide disappeared entirely: at the same time two volumes of argon. Ratio, 34 CS^2 : Arg^2.

2. Argon .... 100 vol.
   Gaseous carbon sulphide .... 73 "

Temperature, 21°. Tension, 5·6 volts. Time, 5 hours.

The sulphide disappeared, with 2·5 vol. of argon.

3. Argon .... 100 vol.
   Gaseous carbon sulphide .... 68 "

Tension, 12·6 volts. Time, 5 hours. Rain of sparks, copious. All the sulphide disappeared. No absorption of argon.

4. Argon (proceeding from the above experiment) .... 100 vol.
   Gaseous carbon sulphide .... 72 "

All the sulphide disappeared; at the same time three vols. of argon. Ratio, 24 CS^2 : Arg^2.

These results indicate that the combination of the argon ceases or becomes insignificant under very strong tensions, the condensation of the sulphide proceeding alone.

Something similar seems to occur with nitrogen, as was remarked before.

I recall the fact that the transformation of oxygen into ozone by electricity is, at the ordinary temperature, correspondingly slight to the combinations of argon, either with benzine or with carbon sulphide. It diminishes equally when the tension becomes too strong. It is less with a series of electric sparks than with the effluvium, because the elevation of the temperature destroys the ozone already formed. The formation of the ozone is also less, although real, with excessively weak tension, because only the quantity of ozone is formed that corresponds to the ratio between the quickness of formation of the ozone with a given tension and its quickness of spontaneous decomposition, of which I formerly pointed out the measure.

There is, then, a certain parallelism between the condition of the electric formation of ozone and those of the electric combination of argon with carbon sulphide. Nevertheless, the latter ceases under feeble tensions, while the formation of the ozone still proceeds, though slowly, according to my old experiments.*

The combination of nitrogen with oxygen follows an opposite course, not taking place under feeble tensions of the effluvium, appearing beyond a certain limit, and becoming more and more active as the sparks grow stronger and stronger.

I have also examined the influence of the effluvium on a mixture of carbon oxide and carbon sulphide.

CARBON OXIDE.

   Carbon oxide .... 100 vol.
   Carbon sulphide .... 60 "

Tension, 6 volts. Temperature, 23°. Time, 10 hours.

There remained only 3·5 of the carbon oxide free from carbonic acid. The yellow matter condensed is a mixture of the proper products of condensation of the carbon oxide and the carbon sulphide, compounds condensable separately by the effluvium.

Yet carbon oxide, treated separately, yields a certain proportion of carbonic acid.†

The mixture obtained with carbon oxide and sulphide, if treated with water, is dissolved in part. The filtered liquor offers an acid reaction, and it contains an oxysulphydric acid, which nitric acid oxidizes at the boiling point, producing sulphuric acid.

It results from this fact that, under the influence of the effluvium, carbon oxide and sulphide exercise a certain reciprocal action.

New proofs are thus presented of the great efficiency of the effluvium in promoting combinations between bodies submitted to its action. These, as I have had occasion to say, in speaking of nitrogen, tend to thus form compounds, condensed and polymerized, similar to those produced by red heat or organic compounds and on metallic oxides; also similar to those engendered under the influence of light, or even found in the tissues of living objects, vegetable and animal.

* From the French of M. Berthelot, in the Annales de Chimie et de Physique.

† The silent or convective discharge.—Trans.

‡ The thermometer used generally in France, always in scientific researches, is the Celsius or centigrade, of which the first degree marks zero and the one hundredth the temperature of boiling water. To reduce to the Fahrenheit system, deduct ten and from the remainder deduct one-tenth of the remainder; double the second remainder and add 50.—Note by translator.

ON THE WEIGHT OF HYDROGEN DESICCATED BY LIQUID AIR.‡

By Lord Rayleigh, F.R.S.

In recent experiments by myself and by others upon the density of hydrogen, the gas has always been dried by means of phosphoric anhydride; and a doubt may remain whether, on the one hand, the removal of aqueous vapor is sufficiently complete, and, on the other, whether some new impurity may not be introduced. I thought that it would be interesting to weigh hydrogen dried in an entirely different manner, and this I have been recently able to effect with the aid of liquid air, acting as a cooling agent, supplied by the kindness of Professor Dewar from the Royal Institution. The operations of filling and weighing were carried out in the country as hitherto. I ought, perhaps, to explain that the object was not so much to make a new determination of the highest possible accuracy, as to test whether any serious error could be involved in the use of phosphoric anhydride, such as might explain the departure of the ratio of densities of oxygen and hydrogen from that of 16 : 1. I may say at once that the result was negative.

Each supply consisted of about six liters of the liquid, contained in two large vacuum-jacketed vessels of Professor Dewar's design, and it sufficed for two fillings with hydrogen at an interval of two days. The intermediate day was devoted to a weighing of the globe empty. There were four fillings in all, but one proved to be abortive owing to a discrepancy in the

* Essay on Chemical Mechanics, II., p. 171.

† Essay on Chemical Mechanics, II., p. 379.

‡ Read before the Royal Society, April 5, 1900.

weights when the globe was empty, before and after the filling. The gas was exposed to the action of the liquid air during its passage in a slow stream of about half a liter per hour through a tube of thin glass.

I have said that the result was negative. In point of fact the actual weights found were one-tenth to two-tenths mgrms. heavier than in the case of hydrogen dried by phosphoric anhydride. But I doubt whether the small excess is of any significance. It seems improbable that it could have been due to residual vapor, and it is, perhaps, not outside the error of experiment, considering that the apparatus was not in the best condition.—Chemical News.

ALCOHOL AS A FOOD.*

By A. T. CUZNER, M.D.

IN order to a proper understanding of the relationship of any article in the Pharmacopœia claimed as food, it will be as well to examine and see if we have a clear conception of what constitutes or qualifies an article, or in other words, what functions, process or processes it is necessary it should serve or conserve in order to the maintenance of growth, repair, and functional activity of the animal tissues.

CELL LIFE.

The different tissues are made up of an aggregation of morphological units, each having a life history of its own. At their death they are resolved into effete material, very deleterious to healthy cells if retained in the tissues.

All cells are the result of the life of previous cells; "*Omne vivum ex ovo.*"

In the course of its development, every cell proceeds from the condition of a unit, in which it resembles every other morphological unit, through a series of stages of gradually increasing divergence, until it becomes an element or part of a special tissue.

The vital functions of the cell may be enumerated as contractility, irritability, automatism, reception of nutritive material and its assimilation, metabolism, secretion, excretion, and finally, reproduction.

During their life history, they are sensitive to and are favored or injured by their environment and by circumstances over which they have but slight control.

Having a very limited power of choice in respect to absorption or rejection of substances brought to them by the circulation, much good is effected, and also much evil, by the presentation of certain drugs in certain conditions.

NUTRITION.

There are three sources of demand for food material. First—To restore or replace the loss consequent upon the wear and waste of the tissues. Second—For the production of energy or force. Third—For the supply and maintenance of animal heat.

VITAL HEAT.

The industrious student of natural history—animal or vegetable—is impressed by the fact that oxygen and oxygenation seem to be the principal factors in all processes of organic life. The established principle of the conservation of energy teaches that light, heat, electricity and motion are energies capable of conversion, the one into the other. To illustrate:

Place and ignite fuel under a boiler—as a result heat; this heat, in the form of steam, acting through the engine, becomes power; this power, acting through the dynamo, becomes electricity, light and heat.

Lavoisier taught that the oxygen taken into the lungs during respiration combined immediately with the carbonaceous materials in the pulmonary tissues and fluids, resulting in carbonic acid and water, evolving heat.

Liebig believed that the heat of the body was produced by the oxidation or combustion of certain elements of the food while circulating in the blood, these substances being converted into carbonic acid and water by the oxidation of their carbon and hydrogen. He divided food into two classes. First, the plastic or nitrogenous elements, albumen, fibrin, gelatin, etc., and second the hydrocarbons and the carbohydrates, or respiratory elements, oils, fats, sugars and starches, regarding them as so much fuel. We dissent from both these scientists as being inaccurate in their views. We hold that the vital or morbid chemical actions and processes going on constantly in the body are sufficient to account for the heat evolved.

We admit, as held at the present day, that the carbohydrates and hydrocarbons taken into the body as food, more largely go to the production of heat and energy than the nitrogeneous elements. During sleep, when the vital or morbid chemical actions or processes of the body are at a minimum, the heat evolved is at a minimum; but when these processes are at a maximum, they attain the maximum.

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Prof. Atwater bases his fallacious proposition that "Alcohol is a Food" on certain facts relating to the development of heat in simple forms of organic life. I thought we had better go over the ground carefully, in order to a proper understanding of his premises and the sophistical conclusion he has reached in his reported proposition, "*That to a certain extent alcohol is a food, and can take the place of certain other foods in the production—through oxidation—of energy, and that he is enabled to measure the amount of energy thus obtained.*"

FOOD.

Upon the right understanding of the term food depends the soundness of the proposition. We cheerfully concede at the outset of our argument *that the oxidation of alcohol results in the evolution of heat and energy.*

The term food has such an extended application that it is almost impossible to give a concise definition of it that will not be open to the objection of excluding some one element considered by many as food, and including some other not usually considered as such.

To illustrate by a few samples:

"Whatever is eaten by animals for nourishment, or whatever supplies nutriment to plants, something that sustains, nourishes and augments, aliment, sustenance or nutriment."—Nuttall's Dictionary.

"That which supplies nutriment. Syn. sustenance, provisions, fare."—Webster's Dictionary.

"Under the term 'food' are included all those substances, solid and liquid, which are necessary to sustain the process of nutrition.

"The first act of the process of nutrition is the absorption from without of those materials which enter into the composition of the living frame, or of others which may be converted into them in the interior of the body."—Dr. J. C. Dalton.

"Whatever is taken to maintain life is food."—Crabb.

"Any substance which, taken into the body, is capable of sustaining or nourishing the living being." Encyclopedic Dictionary. Turning to Encyclopædia Britannica, under the heading "Dietetics"—it has no article on food—we find the following:

"The physiology of the action of alcohol has a very important bearing on the physical management of the mental functions. When a man has tired himself by intellectual exertion, a moderate quantity acts as an anæsthetic, stays the wear of the system which is going on, *and allows the nerve force to be turned to the due digestion of a meal*" (italics mine), and in addition would say, *that an anæsthetic acts on and through the nerve tissues.*—A. T. C. Hence the last clause is faulty. We would define food as any substance or material which can be taken into the body without injury, and applied, primarily, in building and repairing its tissues and framework, and, secondarily, in the evolution of heat, such as the fats, sugars and starches. Dr. Beinfait, of Liege, speaking very forcibly and radically upon this question of what constitutes an article *food*, as follows:

"In order to be a food it is not sufficient that a substance be decomposed or oxidized in the tissues. Under these conditions many harmful substances would be considered food. Ether is decomposed in part; chloroform is partially destroyed." Muscarine, morphine and other poisonous drugs are likewise oxidized in the body. "But do we consider these substances food? Certainly not!

"Other things than decomposition are necessary to nutrition. It is necessary that the decomposition be effected in a way that will not injure the vitality of the cells. A part of the alcohol that is destroyed in the body undergoes this decomposition in a way that is injurious.

"Observe that whereas true food, such as sugar and fat, are destroyed slowly, easily, without provoking too lively a combustion, alcohol is burned too rapidly, provoking a veritable explosion. Suppose that a locomotive has to run a certain number of kilometers; in order to do this, it must be given fuel. This is the coal, which it burns slowly and methodically. If, in the place of coal, we throw naphtha on the fire, or gunpowder, or nitroglycerine, they all produce the same kind of energy, differing in degree and suddenness.

"The combustion may furnish as much heat, or more, as the coal, but it is burned instantaneously, in the form of an explosion. The heat thus produced is not utilized in the machine. What naphtha is for the locomotive, alcohol is to our bodies; it is an explosive, but is not a food." Now as words are but clumsy vehicles of thought, and thought is much more comprehensive than there are words for its conveyance, the above explanations, classifications, and descriptions of what constitutes an article a *true food* may be open to objection.

ALCOHOL AS A FOOD.

If I understand Prof. Atwater right, he does not claim that alcohol is a true food, in any amount, but that it is a food only to a limited extent. Let me quote his reported words: "It has been claimed that I say that alcohol is a food. Mrs. Hunt says she understood it so. If any one did understand it so, let me say again what I said yesterday. Alcohol, if you call it a food, is only a very limited food." In the same address he is reported as saying, "Is alcohol a narcotic? Why, yes; I suppose it is. Is alcohol a poison? Why, yes; under certain circumstances alcohol is unquestionably a poison, a narcotic poison." Again he is reported as saying: "Alcohol cannot serve for building body tissue. It contains no nitrogen, but it is commonly supposed that it can be used in limited quantities for fuel. These experiments [at Wesleyan University] were planned to compare its action as fuel with that of the fat, sugar and starch of ordinary food."

If these reported statements of Prof. Atwater are correct, then in his output of the results of his experiments he has been greatly misunderstood. As I understand his teaching it simply amounts to this:

Alcohol being oxidized in the body, and as oxidation is but a form of combustion, therefore, "when partaken of by man in limited quantities, it performs a like function with sugar, fat, starch—that is, the production of heat; therefore, alcohol can with propriety be classed as a food." He does not claim it is a good or a proper food, or that it can be substituted for natural foods, such as fats, sugars, and starches, but on the contrary, he claims it can only be used in very limited quantities as substitutes for these foods, and that it is a narcotic poison. This then is the outcome of those great and costly scientific experiments heralded at great expense through this broad land, to the deep concern and horror of the unscientific temperance people, and of such great comfort to the lovers of the "social glass." When I was a lad, I was much interested in reading "Æsop's Fables." Among them was one of a mountain in great labor. It belched forth fire and vapor—the thunder roared, the lightning flashed, the rock split, and from the opening came forth a little innocent mouse. It is evident from the quotations which follow from other scientists that they understand Prof. Atwater as I do. But it is also evident, likewise, that the unscientific, and those whose living is made by the manufacture and sale of alcohol, and those who indulge in its use as a beverage, understand Prof. Atwater to teach that alcohol is a food and proper to use as such.

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"Prof. Atwater's own figures, as set forth in Bulletin 69 of the United States Department of Agriculture, do not support his claim. He states that 'whether the body [of the man experimented upon] was at rest or at work, it held its own just as well when alcohol formed a part of the diet as it did with a diet without alcohol. His tables, on the other hand, show at once that when alcohol is substituted in part for carbonaceous foods, there is an increased loss of body nitrogen. We cannot, therefore, understand or accept his statement that alcohol protected the material of the body just as the corresponding amounts of sugar, starch, and fat."—Prof. Seneca Egbert, of the Medico-Chirurgical College of Philadelphia, and Prof. Frank Woodbury, of the Philadelphia Polyclinic and College for Graduates.

"The third conclusion, that the alcohol protected the material of the body from consumption just as much as the corresponding amounts of sugar, starch, fat, is far from being a justifiable conclusion from data given in Bulletin No. 69. The experiments there, in which alcohol was used, show an actual loss of nitrogen, showing a consumption of body proteid during the period.

"Prof. Atwater can draw but one tenable conclusion from Bulletin No. 69; namely, alcohol is oxidized in the system, but is not a food."—Wingfield S. Hall, Ph.D., Professor of Physiology, Northwestern University Medical School, Chicago.

"One fails to find any support for the view that alcohol, like corresponding amounts of sugar, starch, and fat, protects the body against proteid waste, in Dr. Atwater's own figures. Thus in experiment 7, where 417 grains of proteid were given in four days, there was a loss of nitrogen equivalent to 48·2 grammes of proteid.

"In the other alcohol experiment (number 10), there is a similar though somewhat smaller loss of nitrogen. One is, therefore, compelled to admit that these experimental data do not support this third conclusion of Dr. Atwater.

"Indeed, if persons on a diet adapted to keep them in nitrogenous equilibrium regularly showed such losses of nitrogen while using alcohol as are shown in Dr. Atwater's tables, we should have very satisfactory evidence that alcohol was acting as a poison to the cells of the body; that is, as a protoplasmic poison. The two Atwater experiments with alcohol (in Bulletin No. 69) were carried on for so short a period that they throw no light whatever on the food value of alcohol when used continuously. Even if these experiments demonstrated that alcohol can replace a portion of ordinary non-nitrogenous food during four days in a healthy man, this fact would afford no scientific basis for the view that such replacement can be indefinitely carried on without detriment to the organism. It is difficult to believe that an investigator occupying an important government position should be so unintelligent as to give utterance to views favorable to the use of alcoholic drinks on the strength of experiments of such limited scope as those published in Bulletin No. 69."—C. A. Herter, M.D., Professor of Pathological Chemistry, University and Bellevue Hospital Medical School, New York.

Prof. H. W. Conn, Prof. Atwater's associate in the above noted experiments, took care at an early date of their discussion to place himself before the public in the following reported position. He says:

"Alcohol is not used as a food. It is always for its influence upon the nervous system, and one of the well known results is that, at least among Americans, the use of alcohol in small amounts is almost sure to pass speedily into its use in large quantities.

"To state that alcohol in any quantity is safe is a woful misinterpretation. No one can state what is a small and what is a large dose. No one can yet state at what point. A physicist could experiment with gunpowder, and prove it is easily oxidized and gives rise to a large amount of heat and energy. From this it might be argued that gunpowder is a most useful kind of fuel for cook stoves. Such a conclusion would be hardly less logical than the conclusions that have been drawn from these experiments with alcohol, and which regard it as a useful food for the body. Gunpowder is a very unsafe fuel because of its secondary effects, and in the same way the food value of alcohol cannot be determined by its power of being oxidized, but must include the consideration of its secondary effects as well." But suppose we for a moment stop and admit for the sake of argument that alcohol in limited amounts, on account of its being oxidized in the body and thereby generating or liberating latent energy and heat, may be classed as a food, does it not logically follow that all those drugs and chemicals that undergo oxidation in the body are foods, "when taken in limited amounts," whether they be *narcotic poisons or anæsthetics*, and must in consequence be admitted into our list of foods?

Another thought! It is claimed and admitted that alcohol, being an anæsthetic and narcotic, has the power, and exerts the same, of dilating or relaxing the small arteries and capillaries, admitting a larger portion of blood than ordinary, and that the blood at this point loses a large amount of heat; and it is further claimed, and has not been successfully disputed, that the loss of heat in consequence is greater than that produced by the oxidation of the alcohol. If these statements and positions are correct, what becomes of the hypothesis that "alcohol is a food to a limited extent"? What sort of bank assets would a man have who, having on deposit $25, deposited $25 more and drew out $50? You would say that man's assets were nil! Likewise it is with alcohol; it does oxidize in the body, liberating heat, but it at the same time causes a greater loss to the body in another direction by its poisonous action on its tissues.

Therefore, gentlemen of the medical profession, we cannot afford in the interest of science, truth, and morality, to give aid and comfort to the users of alcoholic beverages by admitting alcohol into our list of alimentary substances. We must still retain it in our list of drugs as a *narcotic poison*, useful at times, which times and circumstances must be judged of by each individual physician, the same as he does in regard to the administration of strychnine, arsenic, opium, etc.

* Abstract of a paper read before the American Medical Association, at the June meeting at Atlantic City.

Pork Inspection in Sweden.—Consul-General Winslow, of Stockholm, under date of April 12, 1900, informs the department that during the month of March the health department of Stockholm inspected 8,935 head of slaughtered swine, 65 half-head, and 592 pieces of salted sides, 366 of the last being from the United States. Trichinæ were found in 8 head of the slaughtered swine. The pork of American origin was found healthy.

FALL OF A BRIDGE AT PARIS.

The "Globe Celeste," one of the side shows in the immediate vicinity of the fence of the Exposition, paid for the privilege of erecting over Avenue de Suffren a footbridge that should allow visitors to the Champ de Mars to obtain access to its wickets. This bridge was contructed of protected cement. The structure was about finished, and the removal of the centerings was being begun, a little too hastily, perhaps, when Sunday last, at four o'clock in the afternoon, the platform and pillars suddenly gave way over those who were passing through the avenue. Several had time to get out of the way upon hearing the hearing the first sounds of the collapse; but the terrible accident, nevertheless, claimed numerous victims. The rescuers obtained from the great mass of rubbish five dead bodies and a much larger amount of wounded, some of whom were in a hopeless state. Four of the latter died in the hospitals to which they had been carried. It is hoped that the others may be saved.

THE FOOTBRIDGE OF AVENUE DE SUFFREN AFTER ITS COLLAPSE.

Was the collapse of the bridge due to imperfect construction, to an inadequate drying of the materials, or to a subsidence of the ground. These questions will doubtless be answered by the technical inquest that has been opened. The footbridge was to have been examined the very next day after the removal of the centerings, by the employes of the inspector of highways, and to have been submitted to the same tests as the other footbridges of the Exposition.

Such tests consists in causing the flooring to support a load of 900 kilogrammes per square meter, while the presence of a dense crowd would occasion only a maximum load of 500 killogrammes. It is unnecessay to say that all the footbridges now open to the public have victoriously borne this test.—L'Illustration.

THE PARIS INTERNATIONAL EXPOSITION.

THE ELECTRICITY BUILDING AND GRAND CASCADE.

It will be remembered that one of the great difficulties in arranging the general plan of the commercial palaces on the Champ de Mars, was to place them in such a way as to mask the Great Machinery Hall that was the main structural feature of the Exposition of 1889. Its removal was strongly recommended, but a decision to preserve it was arrived at, and, as its obvious presence could not be made to harmonize with the general scheme, the only alternative was, by concealment, to render its existence harmless to the architectural effect, while its interior could be utilized to the fullest extent. To do this the building devoted to electrical exhibits was placed in front of, and parallel to, the Machinery Hall, extending across the Champ de Mars, while its wings at each end are connected to the rows of buildings ranged on each side and extending downward toward the Seine. The buildings thus connected are the Machinery Hall and the Chemical Industries Buildings, the wings of the Electricity Building passing behind them. By this arrangement there was left a clear space in the middle of the Champ de Mars, occupied by the gardens; and in the center, attached to the Electricity Building, and forming the larger part of its façade, has been placed the great cascade. The main feature of this Château d'Eau is a lofty hemispherical structure, the concave side facing on the gardens, forming at the same time the chief architectural and central feature of the Electricity Building, and the apparent source of the cascade, the water for which will be pumped up from the Seine and allowed to fall into a series of basins at descending levels till it reaches the gardens. This water will be illuminated at night so as to produce the most striking effect of luminous fountains, carried to a further degree than anything heretofore attempted. The height of the fall will be 230 feet, and the length of the basins will be 430 feet. The construction has presented many serious difficulties, especially in relation to the stability of the somewhat fantastic structure, and the heavy loads to be carried by the columns. The work is being executed with great skill by MM. Baudet, Dinon & Company, who have also built the Machinery Hall lately described by us. The façade of this building, relieved by an open arcade running across it on each side of the Château d'Eau to the ends, has a curved outline determined by a range of smaller arches adjoining each other, but at different levels, and resting on heavy piers, diminishing in height on each side of the center; this arrangement gives the profile an elliptical appearance which has a very original and successful effect.

THE PARIS EXPOSITION—THE ELECTRICITY BUILDING AND THE GRAND CASCADE.

Before referring to the construction and general arrangements of this central portion and its extensive wings, we may mention that the curved façade will not, when completed, present a hard outline, but that it will be surmounted with an elaborate frieze, as well as with oriflames and massive ornamentation in hammered zinc, which will give an idea of lightness and elegance. The portion which will appear more or less above the central motive of the Château d'Eau, as well as the two galleries connected with this latter, will be highly decorated with ornaments in color, with stained glass and polychrome ceramics that will certainly have a very beautiful effect.

It should not be forgotten that as the palace will be devoted to electrical exhibits, it is only logical that it should be extravagantly lighted. The illumination will largely depend on 5,000 incandescent lamps of various colors, as well as on projectors throwing powerful colored beams. The highest part of the central arch, or rather hemicycle, of this façade will carry a gigantic scroll on which the date 1900 will be inscribed with electric lights; there will also be a large allegorical figure in repoussé metal representing the Genius of Electricity in a car drawn by hippogriffes, and carrying in her hand the lighted torch of Progress. In order to obtain the most striking idea of the interior of the Electricity Building, it is best to enter from the center of the old Machinery Hall, which is now somewhat ambitiously known as the Salle d'Honneur, but which is in reality little better than a vast and somewhat sombre vestibule that will require a good deal of lighting. Entering the Salle des Fêtes, which, as already explained, is constructed inside and in the middle of the Machinery Hall, the visitor passes almost direct into the center of the Electricity Building. Thus we find ourselves directly at the back of the Château d'Eau.

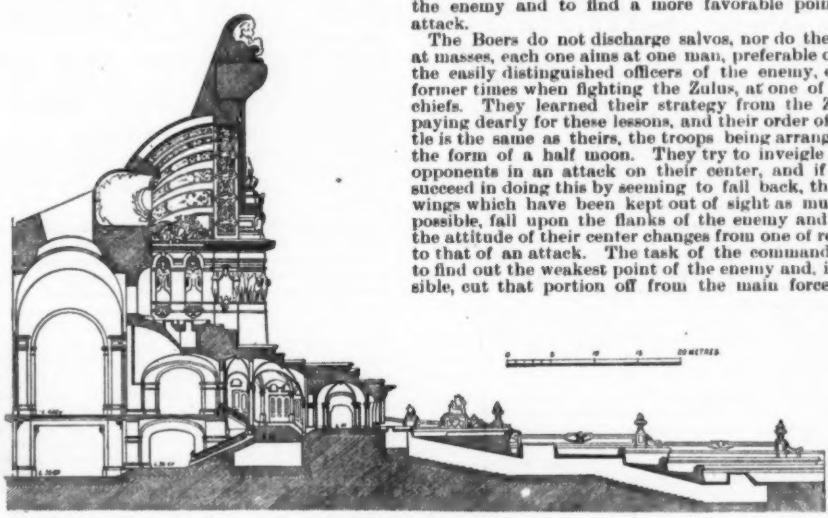
It should be said that this large and solid structure does not at all affect the lighting of the Electricity Building, of which it forms a part, because of the ample top light provided. Looking to the right and left we are able to judge of the effect produced by the successively decreasing range of roof trusses over the central part of the palace. The effect is extremely good, and is largely due to the very happy and elegant form of the lower members of the transverse trusses, which appear like brackets connected by flattened arches, the effect being highly decorative. In the center of the hall the visitor stands beneath the highest part of the building; here the skill displayed in the steel construction is very evident, as indeed is the case throughout the whole of the building, before the covering of fibrous plaster is added. The upper galleries are very extensive, in order to add more exhibiting space, but care has been everywhere taken not to obtain this extra space at the expense of any deficiency of light on the ground floor. This arrangement also leaves a good perspective by which the vast height of the building can be realized. A peculiar feature in the construction is the use of curved steel-framed buttresses, which were necessary at the back of the building to insure its stability. These struts would certainly be unsightly if they were visible, but they are largely masked by secondary buildings, and, of course, are invisible inside the palace, which is completed by lateral wings and by extensions at the back. The former are built with very simple trusses and framing similar to those employed in the 30-meter galleries of 1889; in fact, a certain amount of the framework actually in place in these wings came from the old galleries; the roof trusses with curved inner and straight outer members offer no particular interest. The extensions at the back, which reach from the Electricity Building to the old Machinery Hall, and on each side of the Salle d'Honneur, to which we referred just now, call for no particular remark.

It may be noticed that the connections of the framework of the various annexes, with that of the principal building, is not very satisfactorily carried out, and gives the impression of patchwork, which, indeed, it is, considering that the framing of the old 30-meter has been worked in. No doubt, however, skillful decoration will conceal most of the blemishes.

As we shall, at the date of the inauguration, deal with the general appearance of the Exposition, and the condition of the exhibits, unfortunately very backward, we need not dwell on the subject to-day. As regards the Electricity Building, it is not a little disquieting to notice the actual state of things—apart, indeed, from the German exhibit, which is well advanced. There are numbers of foundations, complete and incomplete, carrying nothing, electrical mains not yet laid, accumulations of packing cases, and loaded

wagons moved by the most primitive means—hand labor—which appears the most popular form of energy for all purposes throughout the Exposition. The location allotted to Great Britain leaves nothing to be desired; it is located where circulation is sure to be most active, close to a stairway connecting the ground floor with the upper galleries.

We have already explained how it is impossible to speak of the Electricity Building without describing the Château d'Eau, the two forming parts of one structure. The section annexed gives a good idea of the general arrangement. The Château d'Eau consists essentially of a hemispherical recess, 98 feet 6 inches across and 36 feet deep, placed at the level of the top of the Electricity Building, and descending by a long series of cascades into a great basin on the ground level running down the center of the Champ de Mars, between the main avenues which will be parallel to the row of palaces on each side. The whole of this work is much behind, and as hand labor has been used exclusively, progress was extremely slow. Moreover, apart from the main columns, the upper basins, and the connecting walls and beams, all of which are largely made with reinforced concrete, the whole structure is of framed timber covered with plaster. Naturally this will be strong enough for the short time it is required, but in passing around the forest of timber, which is not yet concealed, one cannot but realize that a great danger from fire exists, a danger which would be none the less real in spite of the large volumes of water that will be discharged over it. It will be seen from the section we publish that the cascade at its various levels, from its source within the great hemispherical recess, downward, can be illuminated at all points, passages being provided under the basins for the electric installations and operators; at intervals, jets are arranged for an imposing fountain display, which will also be illuminated. As will be seen from the section, the back of the Château d'Eau is connected by a vestibule with the first floor of the Electricity Building, and also by a double stairway passing under the cascade with the ground floor. Moreover, on each side it is connected with the Chemical Industries and Machinery Buildings by open arcades, which are complete, and have a good appearance. These arcades entirely mask the base of the Electricity Building; we shall publish further drawings on a future occasion. It is to be much regretted that this part of the Exposition is in so backward a condition; the successful appearance of the Champ de Mars will depend largely on the completion and operation of this gigantic waterfall.—Engineering.



THE PARIS EXPOSITION—THE ELECTRICITY BUILDING AND CHATEAU D'EAU.

THE BOER ARMY.

IN time of peace the standing army of the South African Republic consists of a small corps of artillery and a corps of field telegraphers; and that of the Orange Free State of an artillery corps and 215 gendarmes; but in case of war the former state calls out all burghers between the ages of sixteen and sixty as well as all natives capable of bearing arms, while the army of the Orange Free State is increased from the ranks of the volunteers, who after their three years of active service is completed, must serve with the reserves in war, when all burghers from eighteen to sixty years of age are also impressed. Troops were raised in this way at the outbreak of the present war with England, and, inspired by love of country, many citizens of the Transvaal who were not required to do so by law, took up arms. We may now often see representatives of three generations among the fighting Boers, as in the case of the men shown in our engraving, of whom only the one on the right is obliged by law to bear arms. This is S. J. Pretorius, who is forty-three years old. The man on the left is P. J. Lemmer, sixty-five years old, and in the center stands J. D. L. Botha, a boy of fifteen. In the Transvaal army there are many such weather-beaten old men and half-grown boys, and these boys are not to be despised as soldiers, for they have been accustomed, from a very early age, to sit in the saddle and to handle firearms. As we know, the Boer army consists to a great extent of burghers who have gone directly from their fields to the war, and as they have chosen their own officers, the latter know exactly what they can demand of their men, each of whom is capable of taking care of himself, in case of need, without the instructions of a commander. The Boer, says a retired English colonel who is well acquainted with their methods, requires no instructions to seek protection from fire, or, where possible, to cover a retreat or to avoid a trap. Each one understands how to act under such circumstances. Nor is it any more necessary to order or to lead a retreat. If the Boers find themselves hard pressed by a superior power they at once turn, without orders, and seek safety in flight. This may seem like a panic, but, in reality, they never lose sight of their pursuers, and as soon as the enemy withdraws a portion of its forces, they turn for attack. They become very much demoralized under heavy fire, but even then their panic is limited to an attempt to escape the clutches of the enemy and to find a more favorable point for attack.

The Boers do not discharge salvos, nor do they fire at masses, each one aims at one man, preferable one of the easily distinguished officers of the enemy, or, in former times when fighting the Zulus, at one of their chiefs. They learned their strategy from the Zulus, paying dearly for these lessons, and their order of battle is the same as theirs, the troops being arranged in the form of a half moon. They try to inveigle their opponents in an attack on their center, and if they succeed in doing this by seeming to fall back, the two wings which have been kept out of sight as much as possible, fall upon the flanks of the enemy and then the attitude of their center changes from one of retreat to that of an attack. The task of the commander is, to find out the weakest point of the enemy and, if possible, cut that portion off from the main force. To follow the Boers for miles is as dangerous as to go after a wounded tiger with unloaded gun. Those who thought that the Boers would be discouraged by the capture of Cronje and his men, or by the death of Joubert, have long since learned their mistake.—Das Buch für Alle.

THREE GENERATIONS IN THE BOER ARMY.

BELGIAN NAIL INDUSTRY.

A RECENT interview with one of the most important nail manufacturers of Belgium elicited the following data relative to the present relation existing between manufacturers and workmen, cause of an impending strike among nail workers, and the crisis through which this industry in Belgium is just now passing. The information may be of interest to nail manufacturers in the United States.

PRINCIPAL SEAT OF INDUSTRY.

Fontaine-l'Eveque, one of five towns in the Charleroi district, is the principal seat of the nail industry in this country.

In March of this year the workmen demanded an increased wage for wire drawers and tack makers in all the works in Belgium, and a 10 per cent. increase in wages of workmen of all other categories. This demand may bring about a general strike in all the nail works, as, in the depressed condition of trade, manufacturers are not likely to grant the demands. Besides, it is considered impossible to fix a uniform tariff of wages, as the means of production differ widely in the various factories. Even in the same factory it would be inapplicable, on account of the organization of work, disposition and system of machines, and aptitude of men operating same.

Workmen are all paid by the job and earn the following daily average wages: Nail makers, 4·88 francs, (94·1 cents); stud makers, 5·71 francs ($1·102); tack makers, 5·32 francs ($1·026); wire drawers, 5·12 francs (98·8 cents); weighers, 4·54 francs (87·6 cents). Ten and one-half hours constitute a day's labor. Prices for raw materials have of late risen, with no proportionate increase in the price for the manufactured article. For instance, the stock price for Paris points—slender, round nails—is less than the price of wire rod.

NUMBER AND OUTPUT OF NAIL WORKS.

There are in Belgium, exclusive of two small works situated at Hodimont and Luxembourg, nine nail factories, six of which are at Fontaine-l'Eveque, one at Brussels, one at Marchienne, and one at Gentbrugge; but, owing to American, German, and French competition, Belgian manufacturers admit their inability to place their surplus production on foreign markets heretofore exclusively controlled by them.

The crisis started about two years ago, when American goods began to supplant the Belgian article upon the various European markets.

Manufacturers here also admit difficulty in compet-

ing against the German nail syndicate, which comprises eighty-six nail works, and which is reported as supplying home orders at high rates and placing its overproduction for exportation at whatever price they can get. It is also said that the German manufacturer is favored by an export premium, and also by the entry duty of 15 francs ($2·895) per 100 kilogrammes (220·46 pounds) on tacks.

Although the United States furnishes Belgium with wire rod, the difference in price of the cheaper grade American and Belgian article is 5 francs (96·5 cents) per 100 kilogrammes (220·46 pounds).

At Fontaine-l'Eveque, the annual production of nails amounts to 18,000 tons, 9,000 tons of which are consumed in the country, the surplus—which greatly exceeds the demand—being held for exportation.

Belgian manufacturers realize that markets are constantly escaping them; that the tonnage of exportation is yearly diminishing, and that they will be obliged to curtail production. They regard with especial apprehension the progress made on foreign markets by American manufacturers during the past few years, says George W. Roosevelt, Consul at Brussels.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Cabinet-Making School at Magdeburg.—The consular reports of late years contain a vast amount of information on the subject of technical and industrial schools in Europe, and they clearly show that Germany easily takes the lead in this line by annually appropriating large sums of money for instruction in almost every art and industry. It is generally recognized that commercial progress throughout this country depends largely upon the condition of technical education. Outside of the many schools for agriculture and commerce, the system of special schools for other purposes is wonderfully complete. The tailors, the painters, the shoemakers, the smiths, the brewers, the butchers—each trade has its schools for theoretical and practical training.

I recently discovered at Magdeburg a school that roused my interest to an unusual degree, says Consul Henry W. Diederich, of Bremen. Though somewhat familiar with educational work done in this country, and also with its technical schools, I had never yet seen such an institution. It seemed admirable, so much so that I deemed it my duty to call attention to it, as it may interest others. There is no imposing architecture of any kind; no lecture halls, no chapel, no museum, no gymnasium, no campus; there are only half a dozen rooms on the top floor of a four-story building in a narrow side street. It has no faculty of brilliant scholars, but only a few devoted men. There is no liberal endowment by millionaire philanthropists, but scant support from the government, hardly sufficient, I was told, to keep body and soul of the institution together.

The school was found by a Mr. Kiefhaber, a citizen of Magdeburg, a plain mechanic, a cabinet-maker, but a genius at his trade. After having been prosperous in business, he wished to aid young men apprenticed to the trade of furniture making and carving in his native town.

Under Prussian laws youths who, after having passed through the public schools, intend to learn a trade are required to continue attending some school for some nights during the week and for two hours on Sunday. Such schools are called "Fortbildungsschulen," a significant but untranslatable term signifying a school where the education is to be continued. Mr. Kiefhaber had, through his own long experience, become convinced that such schools could not accomplish this purpose satisfactorily, because boys at the age of from 14 to 17, after having been hard at work all day long, can not be in condition, either physically or mentally, to attend school for hours with any benefit to themselves. He therefore conceived the idea of establishing the school above referred to. To accomplish his object, however, he needed the assistance of the Magdeburg union in the line of cabinet-making, sculpturing, and carving. Their co-operation was granted to him to the fullest extent. All the boss mechanics of cabinet-makers, though most of them are men without any means, and therefore can ill afford to lose even time, agreed to send each of their apprentices to this school for a whole forenoon in every week, and also to take turns in assisting in the work of teaching. As these lessons are given every day from 8 to 12 o'clock, each apprentice in Magdeburg gets four lessons a week, all bearing directly upon his future work.

I believe it is impossible to conceive of anything more practical than the teaching in these classes, of which there are three, as it is a three years' course. No question is put, no fact explained, no definition given, and no drawing made, but has some bearing upon either the materials or the tools or the purposes of the combined trades mentioned above. No step forward is taken until the why and wherefore of the preceding step has been fully understood by everyone in the class. And, as in all schools of like character, great stress is laid upon free-hand drawing. This is to give the young men not only all the technical knowledge needed, but also to train the eye and the mind in designing every part of the various styles of furniture, as well as artistic decorations in wood carving and inlaid woodwork. Such work, when added to talent and diligence, must lead to thoroughness and originality.

The young men in the last year's course were scattered all over the room, each standing before a blackboard, engaged in drawing some part of a piece of furniture or some ornamental carving, while the teacher moved about examining the work. Upon inquiry, I was told that this was a lesson reviewing, in an objective way, the oral instruction given by the teacher at the last recitation. I will add that every student was given a different part of the work, so that no two of them had the same drawing to make.

There are only a few salaried teachers employed, while there are always several boss mechanics present, as already stated, assisting in various ways. This must be an excellent way for these men to get and maintain the confidence and respect of their apprentices; for when young people see that their masters are not only able to show them how to handle tools in the workshop, but are also fully capable of instructing them theoretically, it can not fail to have a beneficial influence upon the relations between the masters and the apprentices. Surely such teaching unites theory and practice in a wonderfully complete way.

I have already said that the boss mechanics in the cabinet-makers' trade union contribute their own time to this school without any compensation, and also give each apprentice one full forenoon in every week to attend the school. This is a great sacrifice for most of them. Mr. Kiefhaber, the founder of the school, for several years not only devoted his own time to this work, but has paid most of the expenses himself. Surely, not the least interesting feature of this institution is its benevolent object of reaching young people from the humblest walks of life, elevating and educating them so as to make of them good mechanics, artisans, and citizens.

The attention of the government, both municipal and national, is now being called to the importance of this work, and it is hoped that the institution will soon be placed on a sounder financial basis. I have no doubt that this school, if properly supported and wisely conducted, will, in the course of time, build up in Magdeburg an industry which will give employment to hundreds of artisans and mechanics, and bring renown to the city for its manufacture of fine and artistic furniture, as Dresden is noted for its fine chinaware, Munich for its works of art, Leipzig for being the great book mart, and so forth.

To an American, this school for apprentices at Magdeburg is interesting, chiefly because it again shows to what an extent intellectual and technical training is carried on in this country, in order to achieve and maintain the foremost position in the industrial world.

Opening of Railway in Salvador.—Consul Jenkins, of San Salvador, on March 20, 1900, reports:

On the 19th instant train service between San Salvador, Santa Ana, and Acajutla was opened, saving four hours, as compared with the old, tedious route. The railway company will build custom-houses for the government, giving commerce greater facilities than now exist, not only in the way of quicker passenger transit, but also of freight, which was formerly cained part of the distance in springless carts, much to the detriment of certain classes. Shippers will be benefitted to the extent of about 50 per cent. reduction on freight rates between San Salvador and the coast. President Regalado formally declared the line open for public-service, and the first train, adorned with the national colors of Salvador, England, and the United States, started for its destination. The Consul of the United States occupied a seat in the carriage of the President by special invitation, and was the only foreign representative thus favored at this ceremony.

Agriculture and Irrigation in the Rio Grande Valley.—For the past two years the farmers in the Rio Grande Valley below El Paso, Texas, and Ciudad Juarez, Mexico, have had no water with which to irrigate their lands, and there is no promise of a current in the Rio Grande River during the present year—that is, with the exception of the extra-seasonal water that comes down for a brief period, principally during the month of May. This flood water serves no practical purpose, unless it could be held in reserve. Agriculture depending upon irrigation derives but slight benefit from water obtainable for about one month in twelve. It may be stated, therefore, that this valley is now in the third year of a drought, and the consequences are patent to the most casual observer. Agriculture has languished, and dwindling population and diminished business testify to the apparently hopeless condition due to the lack of sufficient water to irrigate the soil. Fruit trees have withered and died, alfalfa farms have burned and perished, and vineyards once producing an abundance of grapes have ceased to yield. People have been compelled, in many instances, to seek a livelihood elsewhere and in other pursuits than the cultivation of the soil. Formerly, there were in Juarez and the valley below this city about 20,000 people; now there are less than 8,000.

Spreading southeast of Ciudad Juarez are more than 100,000 acres of land as fertile—when irrigated—as the bottoms of the Nile. Mr. Weber, a representative business man of this place, who has a thorough knowledge of existing conditions and latent resources, says the valley below and about El Paso and Juarez is capable, with sufficient water, of producing more than $2,000,000 annually in grain, grass, and fruits. Without irrigation, it is a dry waste of alluvial deposit upon which nothing will grow but cottonwood trees and useless bosk.

From the fact that the soil is naturally so fertile, it may be reasonably concluded that more water than formerly has been drawn from the river in Colorado and New Mexico. There, population has rapidly increased, and agriculture has been extended to the limit of the river's capacity to supply irrigation. The consequence is the river ceases to be a river at all before it reaches El Paso, Texas, and Ciudad Juarez. According to the census of 1890, 4,000 persons were engaged in the cultivation of 100,000 acres of land in the Rio Grande Valley of New Mexico. The number of persons engaged in agriculture and the number of acres added to those already cultivated, it is estimated, have more than doubled. As the amount of water drawn from the Rio Grande in northern New Mexico can not be diminished, the outlook for the farming and dependent interests in the valley about and below El Paso and Ciudad Juarez is unpromising.

Each year, with the melting of the snow in Colorado, there is a flood in the Rio Grande. Sometimes the river becomes a wide, raging torrent of large volume. The water dashes by for a brief period, and then the river becomes dry again. In 1897, the flood came in such volume as to endanger property along its course. In 1898, it was almost as high. In 1899, there was a brief flow, which was quickly spent. The outlook for a large volume of water this spring appears to be unpromising.

This valley will never again prosper unless something is done to provide water for the purpose of irrigation. And whatever may be the law supporting or opposing the claims of the people of Mexico against the United States for the loss occasioned by the diversion of the water, the construction of a dam by government to impound the flood waters of the Rio Grande would constitute an act of comity which would restore prosperity to a languishing valley and benefit the inhabitants of western Texas and southern New Mexico, as well as the citizens of Mexico residing on the south side of the Rio Grande.—Charles W. Kindrick, Consul at Ciudad Juarez.

Number of Physicians and Dentists in Germany.—Consul Pitcairn writes from Hamburg, March 26, 1900, that the number of practising physicians in the German empire has increased during the last thirteen years from 15,824 to 21,725, or 56·25 per cent. During the same period, the population has only increased 14 per cent. In Prussia, of 1,620 military and marine physicians, only 31 out of every 100 now become general practitioners. Formerly, 57 out of every 100 left the service and entered general practice, demonstrating that the ranks of the general practitioners of medicine are becoming more and more crowded. The number of midwives is not increasing in comparison with the population.

There are 12,099 practicing dentists in the German empire. American dentists, or German dentists who have received their education in the United States, command the best fees and are held in the highest repute.

American Horses in Switzerland.—Consul Gifford writes from Basel, April 10, 1900:

For several years past, American driving and saddle horses have been imported in large numbers into Switzerland. This spring, the business seems to be assuming unusual activity, and one shipment of seventy-two American animals has already arrived in Basel. These are offered to the public exclusively as draft and cart horses. The Swiss importer obtains for them about 1,400 francs ($270) each, and up to this time they appear to have given satisfaction. They are bought up all the more eagerly, since it is thought that further opportunities for such purchases may not be frequent in the near future. It is reported here that the demand for American horses for South Africa has occasioned a scarcity which may render exportation to Europe impracticable for the present.

Proposed Brussels-Antwerp Electric Railway.—The government has provided, in the estimates before the chamber, for the construction of an electric tram service between Brussels and Antwerp. The new line is considered to be the forerunner of others, which will shortly supersede steam locomotion, except for the transport of merchandise. The scheme provides for the construction and operation of an electric railway direct from Brussels to Antwerp, without any intermediary stop, and asks that the duration of the concession may be sixty years.

Several bids have already been submitted to the government, which, however, reserves the right to select the offer satisfying all the conditions of the bill and presenting the most complete guaranty of good and prompt execution.

The new line must be established in a manner allowing the trains to pass over an uninterrupted line of rails without risk of any possible encounter, either from teams crossing the rails or from trains. In fact, the line must be so constructed as to avoid all obstacles that might involve stopping of the trains. The bill further provides that trains, whether composed of one motor carriage alone or with one or more trailers, must be supplied with powerful brakes. Not having any obstacle to fear, they may acquire a very high rate of speed. That proposed by the bill is 100 kilometers (62·136 miles) per hour, which would permit trains to make the run between Brussels and Antwerp (27 miles) in twenty-five minutes.

It is predicted that very shortly after the completion of the road the traffic will be so heavy as to necessitate running trains every five minutes during the greater part of the day. The carriages will be divided into first and second class sections. The government reserves the right to fix the tariff, which is expected to be 25 per cent. lower than prices now charged by the State railroad between Brussels and Antwerp. Reduction of tariff beyond the limit prescribed and issuing of subscription tickets cannot be made unless authorized by the government. Transportation of all kinds of merchandise, as well as registered baggage, will be positively excluded.

Although the bill provides for a concession for sixty years, at the expiration of which the railroad and its entire equipment become the gratuitous property of the State, the government reserves the right to redeem the road after the expiration of the first ten years, or sooner, if considered advantageous. The cost of construction and equipment is estimated at about 40,000,000 francs ($7,720,000).

It is interesting to note that in 1834 Belgium voted the building of the State railroad running from Brussels to Malines; it was rapidly completed, and 1835 saw the inauguration of the first railway on the Continent. In view of the propositions in various countries to establish electric lines between important centers—such as Paris-Havre, Brussels-Paris, Manchester-Birmingham, New York-Philadelphia—the promoters of the line between Brussels and Antwerp are ambitious to have the honor of inaugurating the first important electric line in 1900.—George W. Roosevelt, Consul at Brussels.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Ink Tablets are prepared in the following manner: Extract 42 parts of Aleppic gall nuts and 3 parts of Dutch madder, with a sufficient quantity of warm water. Next, filter this liquid, dissolve in it 5⅛ parts of green vitriol and add two parts of hyrolignite of iron and 1¼ part of indigo solution. The mixture is evaporated to dryness at moderate heat and shaped into tablets of suitable size. A portion of these tablets dissolved in 6 parts of hot water, gives an excellent writing and copying ink.—Die Werkstatt.

Artificial Nutmeg.—According to the Amsterdam Journal of Commerce, there are made in Belgium artificial nutmegs in so clever a manner that they can hardly be distinguished from genuine ones, especially if mixed with the latter. A chemical analysis has shown them to consist of a mixture of finely powdered nutmeg (from extracted or injured kernels) and about 20 per cent. of mineral substances. The following means of detection are given:—1. When the kernels are cut the well known plant-like structure so characteristic in genuine nutmeg, is absent. 2. If the kernels are treated for 3 minutes with boiling water they become soft and can be rubbed up into a powder with the fingers. 3. Upon being burnt they leave about 18 per cent. of ashes, while true nutmeg contains but 2 to 3 per cent. of ashes. 4. The imitation nuts are generally much heavier than the genuine article.

Cleansing Liquid for Lithographic Stones.—The object of this liquid is to remove every trace of the old writing, or design and to produce a new surface on the stone, admitting of using it again without having to grind it off. The liquid is prepared as follows:—

To 14 parts (by weight) of a saturated alum solution, add 8 parts (by weight) of a saturated strontium nitrate solution, then 6 parts (by weight) of nitric acid (40° B) and finally 14 parts (by weight) of water and stir the whole well.

For cleaning a stone with this liquid, it is immaterial how long the writing or pattern has been on it. The raised portion of an old design may previously be rubbed off. After the stone has next been carefully rinsed with water and wiped off, the new liquid is poured over it. It is at once distributed as carefully as possible over the whole surface of the plate and rubbed in for one or two minutes. Now the stone is placed on edge, so that the superfluous liquid can drip off, whereupon the stone will dry exceedinly quickly. After the drying it has a handsome clean surface and is extremely susceptible for most small matters and drawings.—Seifensieder Zeitung.

Chlorine and Its Compounds.—Chlorine constitutes a green gas of pungent odor, and is exceedingly poisonous, if inhaled. In nature, it does not occur in a free state, but always in combination with metals. It possesses such great affinity to metals, that even if free chlorine were present in nature, its existence would not be possible for a long time.

The commonest mineral containing chlorine is cooking salt or rock salt, as it is called in the crude state, which is known to be a compound of sodium and chlorine, for which reason it is called sodium chloride in chemistry chlorine is separated from cooking salt by heating the salt in the mixture with manganese and sulphuric acid. By this process, chlorine, sodium-sulphate, manganese-sulphate and manganous chloride are formed. This however is not the ordinary method of producing chlorine wholesale. For the latter purpose the hydrochloric acid first produced from cooking salt is used, which is boiled with artificial manganic peroxide or native manganese. From this results chlorine and manganous chloride.

Chlorine enjoys extensive employment for bleaching and disinfecting purposes. But since chlorine represents a gas and, therefore is hard to handle as such, it is generally put into a liquid and especially a solid form. This does not imply, of course, that chlorine is liquefied or converted into a crystalline, solid state, but it is combined with liquids or solid bodies, which are then used as desired.

Chlorine is rather soluble in water and by introducing it into water, a comparatively concentrated chlorine-solution is obtained, which is used for bleaching as well as for disinfection in the vicinity of its place of production. But a transportation of this chlorine solution is impossible for two reasons; firstly, rather considerable costs of transportation would accrue; secondly, the transportation vessels would suffer exceedingly by the destructive influence of the chlorine and would soon deteriorate. Therefore, it is preferred to prepare a solid body, which takes up comparatively little space and consequently can be easily packed and readily transported. This solid body is chloride of lime.

In order to produce chloride of lime, gaseous chlorine is conducted over slacked lime spread out in large chambers. The lime eagerly absorbs the chlorine, with formation of hypochlorite of lime and calcium chloride. The effectual component of chloride of lime is hypochlorite of lime.

The bleaching action of chlorine is in reality an oxidation effect. Chlorine decomposes water into its two component parts, hydrogen and oxygen. The latter, in statu nascendi, easily attacks the dye stuff of the fiber and destroys it. In bleaching with chlorine great care must be used, since otherwise the fabrics will be injured. Attention should especially be paid to a thorough washing out after the bleaching, which is best accomplished in running water. Hydrochloric acid is formed in bleaching with chloride of lime, which, if not entirely removed, renders the textile fiber brittle.

Chlorine is also employed extensively for the production of organic compounds, especially such as are used in the dye stuff industry. The most important is probably the preparation of benzaldehyde, called also bitter almond oil, and the manufacture of benzoic acid. In order to obtain these bodies, gaseous chlorine is passed under suitable conditions into toluol. If certain conditions of manufacture are observed, double or triple chlorinated toluol results. The double chlorinated product is called benzal-chloride, the triple chlorinated benzo-trichloride. By sapponification, e. g., by boiling with milk of lime, bitter almond oil results from the benzol-chloride, and benzoic acid from the benzo-trichloride. Both products are largely employed in the production of dyestuff.—Farben Zeitung.

SELECTED FORMULÆ.

The Care of the Teeth.—

MOUTH WASHES.

Cardamom and Snake Root.

White castile soap	1 oz.
Tincture of cardamom	2 drms.
Tincture of asarum	2 "
Oil of peppermint	30 drops.
Oil wintergreen	30 "
Oil cloves	5 "
Oil cassia	5 "
Glycerin	5 ozs.
Alcohol	13 "
Water	13 "
Carmine color N. F. sufficient to color.	

Mix the soap, glycerin, water, alcohol; add the remainder of the ingredients; let stand a few days and filter at a low temperature so that it will not become turbid afterward.

Salol Astringent.

Salol	30	grns.
Tannin	30	"
Saccharin	4	"
Safranine hydrochloride	½	"
Spirit lavender	225	min.
Spirit melissa	225	"
Spirit peppermint	12	drops.
Cologne water	2¾	ozs.

Witch-hazel.

Hamamelis water	18	ozs.
Tincture myrrh	9	"
Honey of roses	4	"
Tannic acid	½	"
Sodium salicylate	½	"

Thymobenzoform.

Thymol	4 grns
Benzoic acid	14 "
Tincture eucalyptus	225 min.
Oil peppermint	9 "
Chloroform	15 "
Alcohol	3 ozs.

Twenty drops in a glass of water as a mouth wash.

Botot's.

Cloves	30
Cinnamon	30
Anise	30
Cochineal	20
Alcohol	2,000
Oil peppermint	15

The drugs in coarse powder are macerated in the alcohol for one week, with occasional agitation. Filter and add the oil of peppermint.—American Druggist.

Home-Made Kumyss.—Kumyss is commonly made by adding yeast to cows' milk and fermenting. The best results are, however, obtained from the use of mares' milk, this being the basic ingredient of the original Russian kumyss. Mares' milk is less rich in casein and fatty matter than cows' milk, and is therefore more easy of digestion.

Cows' milk is always used in this country, and it answers the purpose admirably in most instances, but a better preparation is obtained by diluting with water to reduce the percentage of casein, etc.

Mares' milk contains 8·75 of milk sugar, cows' milk only 5·35; it is, therefore, necessary to add some of this to the preparation as made from cows' milk. The following formula answers very well. Take of—

Fresh milk	12	ozs.
Water	4	"
Brown sugar	2½	drms.
Compressed yeast	24	grns.
Milk sugar	3	drms.

Dissolve the milk sugar in the water, add to the milk, rub the yeast and brown sugar down in a mortar with a little of the mixture, then strain into the other portion. Strong bottles are very essential, champagne bottles being frequently used, and the corks should fit very tightly; in fact, it is almost necessary to use a bottling machine for the purpose, and once the cork is properly fixed it should be wired down. Many failures have resulted because the corks did not fit properly, the result being that the carbonic acid gas escaped as formed and left a worthless preparation. It is further necessary to keep the preparation at a moderate temperature, and to insure the article being properly finished the bottles are to be gently shaken each day for about ten minutes to prevent the clotting of the casein. It is as well to take the precaution of rolling a cloth round the bottle during the shaking process, as the amount of gas generated is great, and, should the bottle be of thin glass or contain a flaw, it may give way. Some few days elapse before the fermentation passes into the acid stage, and when this has taken place the preparation is much thicker. It is now in the proper condition for allaying sickness, being retained by the stomach when almost everything else is rejected.

A fairly good quality of kumyss may be prepared in a small way by following the directions given below:

Fill a quart champagne bottle to the neck with pure cows' milk; add two tablespoonfuls of white sugar, first dissolving it in a little water by aid of heat; add also a quarter of a 2-cent cake of compressed yeast. Then securely fasten the cork in the bottle and shake the mixture well; place it in a room having a temperature of from 70 to 80° F. for six hours, and finally in the ice box for about twelve hours. It is then ready for use.—American Druggist.

Scale Pomade.—

Benzoic lard	120	parts.
Precipitated sulphur	4·0	"
Lanolin	20·0	"
Alcohol (90 per cent.)	20·0	"
Salicylic acid	1·0	"
Geranium oil	1·0	"
Rose water	60·0	"

—Pharmaceutische Post.

WORKING SILICA IN THE OXY-GAS BLOWPIPE FLAME.

THE plastic state of silica, and the elasticity of fine threads of vitreous silica, were first observed by M. Gaudin (Comptes rendus, viii., 678, 711) in 1889; but his observations seem to have attracted but little attention, and the valuable qualities of "quartz threads" remained unutilized till they were independently rediscovered and applied by Prof. C. V. Boys in 1887.

Similarly, M. A. Gautier succeeded, in 1869, in making very narrow tubes of silica, and showed such tubes in Paris in the year 1778, but he failed to make further progress, even with the aid of M. Moissan's electric furnace (Comptes rendus, cxxx., 816, March 26), and his early work was so completely forgotten, both in France and England, that the latest French worker on the subject, M. A. Dufour, was evidently unaware of its existence a few weeks ago (Comptes Rendus, cxxx., 775, March 19).

But though it thus appears that Prof. Boys was not, as has been supposed, actually the first physicist to draw silica into threads, or work it into fine tubes, there can be no doubt but that his observations, methods of working and experiments have formed the basis of all that has been done since the publication of his first paper in 1887.

In June, 1899, one of the authors of this article exhibited (in conjunction with W. T. Evans), at the Royal Society's soirée, a tube of vitreous silica, about 12 cm. in length and 1 cm. in diameter, and at the same time showed the process by which it had been made. Since that date we, the present writers, have made a good deal of further progress. We have succeeded in making longer tubes of various thicknesses, and in joining such tubes both end to end and at right angles. On February 22, we filled and sealed an ungraduated mercury thermometer made entirely of vitreous silica*; and, what is equally important, we have entirely overcome the difficulty caused by the great tendency of quartz to splinter when suddenly thrust into the oxy-gas flame. We therefore now publish a short account of our methods in the hope that they may enable others to take advantage of the new material without undertaking a tedious preliminary investigation into its properties and the methods of working it. We may, perhaps, be permitted to add that we have already commenced experiments intended to test the suitability of silica for use in mercury and air thermometers, especially in regard to the fixity, or otherwise of their zero points, that M. A. Dufour is engaged on similar work, especially in relation to high temperature thermometers, and that we are also studying the fitness of silica apparatus for researches on the properties of pure gases.†

To Prepare Non-splintering Silica.—The best form of silica for use before the blowpipe is rock crystal. This may be obtained in the form of chippings, or in masses which have proved unsuitable for optical work. We have experimented with the lighter particles of Kieselguhr, after well washing them with strong hydrochloric acid, and also with well-washed precipitated silica; but, though these can be worked before the blowpipe without much difficulty, they have not proved satisfactory in our hands, as they yield an opaque product which is only suitable for a few purposes.

In order to prepare non-splintering silica from native masses of rock crystal, the latter must be heated in a Bunsen flame, unless they are already perfectly clean, until the outer impure layers can be removed easily by the blow from an iron pestle or hammer. The clean masses of silica must then be heated in a vessel containing boiling water for some time, and dropped while hot into clean cold water. This treatment will cause the masses to crack to such an extent that they may easily be broken into fragments of convenient dimensions by sharp blows from a clean hammer. When the material has thus been broken up, the fragments must be examined one by one, and all those which contain foreign matter must be rejected. Finally, the selected fragments must be heated to a yellow-red heat in a platinum dish, and then quickly thrown into deep cylinders containing cold distilled water. After the quartz has been treated in this manner twice, it will be found to be semi-opaque and very much like a white enamel in appearance. It may now be brought safely into the oxy-gas flame, or be pressed suddenly against masses of white-hot plastic silica without any preliminary heating, such as is necessary in the case of the natural quartz. These processes do not occupy much time, and the use of the prepared material saves a great deal of time and trouble at the subsequent stages. We have tried unprepared opal and natural cloudy quartz, but both these splinter badly.

The Blowpipe.—We have worked silica both in the flame of an ordinary "blow through" jet, and in the flame of a good "mixed gas" burner. We find the latter gives by far the more satisfactory results. The large "blow through" burners, such as may be used for welding and melting iron, or for melting platinum, do not give satisfactory results, from an economical point of view, with silica.

Some Necessary Precautions.—In working silica it is necessary to use very dark glasses to protect the eyes. The darkest glasses usually supplied by spectacle makers are not, in our experience, satisfactory. We use spectacles made specially from glass so strongly darkened, that it is difficult at first to work with them at all. We lay some stress on this matter, as we are satisfied that want of care in selecting the spectacles would be likely to result in injury to the sight of any one who should work silica before the blowpipe frequently and for long spells.

Relative Difficulty of Working Glass and Silica.—The fashioning of apparatus from silica before the blowpipe is expensive, for the consumption of oxygen is large, and it demands some patience to build up large pieces of apparatus from shapeless masses of quartz. But owing to the remarkable fact that properly prepared silica, and also silica rendered vitreous by fushion, may be plunged directly into the hottest part of the oxy-gas flame, and afterwards be suddenly cooled, and reheated and recooled, apparently as frequently as one pleases, without any risk of its crack-

* Nature, April 5, p. 540.

† This will obviously involve a careful investigation into its power of condensing gases and vapors.

ing, it is really very much easier to manipulate silica than any variety of glass. The most careless and most inexperienced worker runs no risk of breaking his apparatus through want of skill in managing the flame, or through the exigencies of his affairs compelling him to put aside half-finished work. It is important, however, to apply the flame to the opaque prepared silica, in the first instance, in such a way as to avoid the forming of air bubbles. Our practice is to heat first the lowest surface of each fresh mass of silica, and to take care that fusion proceeds regularly from below upward. If this be done, a perfectly clear glass-like product is obtained.

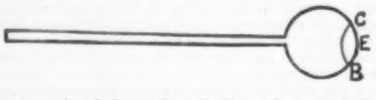
Silica is very liable to exhibit a phenomenon resembling devitrification, especially at the earlier stages before the traces of sodium and lithium, which seem to be present in most quartz, have been expelled. In order to avoid permanent injury to the finished work from this cause, care must be taken to employ a quiet flame. If this be done, any devitrification that may appear will be removed easily by reheating the disfigured surfaces.

To Make Silica Tubes.—Before one commences to construct apparatus of silica, it is well to prepare a stock of vitreous material in the form of rods about 1 mm. in diameter. These are made by holding a small lump of non-splintering silica in the flame, by means of forceps with platinum tips, so as to melt one corner of the mass, pressing a second fragment of the material against the heated spot till the two adhere, heating the second portion from below upward until it assumes a clear vitreous appearance, then adding a third fragment of silica to the second, a fourth to the third, and so on, until an irregular rod has been formed. Finally, this irregular rod must be reheated in small sections at a time, and drawn out to the desired extent. These rods are easily made by any one; a capable laboratory boy will produce about a score of rods 20 cm. long in an hour, after a few days' practice at the work; but his consumption of oxygen must be watched closely. The platinum tongs do no suffer much if one works in the manner described, for after the first start off they are only used to press cold fragments of silica against the fused ends of the growing rods. Our forceps have been used for four beginners, and are quite unharmed after several years.

When a supply of the rods of vitreous silica has been prepared, bind a few of them, at their ends, with fine platinum wire round a rod of platinum 1 to 1·5 mm. in diameter; heat the silica cautiously till the rods adhere to one another, and then withdraw the platinum core. If the tube is not perfect, add bits of silica at the defective places and reheat them. Close one end of the rough tube thus produced, and blow a small bulb upon the closed end, proceeding in the manner employed for producing glass bulbs. Heat the bottom of the bulb, attach a rod of silica to it, reheat the whole bulb, and then draw it out into a tube. Blow a fresh bulb at one end of the fine tube thus made, and draw this out in its turn, until the tube is six or seven cm. in length. By the time this is accomplished the worker will have discovered that the hottest spot in his oxy-gas flame is just inside the tip of the inner cone, but not too near to the orifice of the jet; and after this, if he can perform the simpler operations of glassworking, he will, with a few weeks' practice, find it easy to make larger apparatus by following the simple instructions given below.

The chief difficulty met with when one wishes to make large bulbs, tubes, etc., is due to the fact that the only thoroughly satisfactory burners give comparatively small flames, and that it is only the hottest parts of these flames that give the desired results. There is no doubt, however, that suitable combinations of small burners could be contrived if they should be demanded, for the production of apparatus of really considerable dimensions.

In order to convert a small bulb of silica into a large tube, proceed as follows: Heat one end of a fine rod of vitreous silica, and when it is in the plastic state apply it to the bulb at the point, *C*. Then soften the



adjacent parts of the rod, and allow them to fall upon the bulb so as to form a ring, *C B*, attached to the bulb. Heat the end of the bulb and *C B* till the silica softens, then blow out the end in the usual manner. If this process is repeated the bulb will first become ovate and then form a short tube which can be lengthened, practically speaking, indefinitely. Tubes of 1·5 cm. diameter and of considerable length are easily made in this way by a patient person. It does not answer to add lumps of silica at *E* and then to blow them out; we had no success in working silica till we abandoned that method. The sides of the tube formed in that way are too thin, and blow-holes constantly form in them. The tubes are easily thickened, when necessary, by adding rings of silica, reheating these, and blowing them to spread the material, as one would do when working glass. It is best to blow through a chamber containing potash. If this is connected to the end of the silica tube by india rubber "valve" tube, one is able to move the silica tube with sufficient freedom. If a large tube is being made, it is best to blow out the softened material while it is still in the hottest part of the flame, but smaller objects may be transferred to the less hot parts of the flame with advantage at the moment of blowing. When a comparatively large object must be uniformly heated, it is convenient to place a sheet of silica in front of the flame, a little beyond the object to be heated, in order that it may throw back the flames upon those parts of the material which are turned away from the chief source of heat. A suitable plate of silica is easily made by sticking together small, rounded masses of vitrified quartz.

We find that it is not difficult to produce tubes of various thicknesses and various internal diameters by heating and collapsing thin tubes made as described above, and that fine capillaries, "thick millimeter tubes," and tubes of two or three millimeter bore, of moderate thickness, can be produced in this way. Thermometer stems are best made by adding rings of silica to small bulbs, thickening them in the flame till their cavities are very small, and then quickly drawing them out while soft. Finally, we may add that tubes of silica can as readily be sealed to one another as tubes of glass, and that T-pieces and side tubes generally may be formed by fixing rings of silica in the positions to be occupied by the side tubes and extending them by blowing as already described, or by attaching tubes of suitable dimensions, previously prepared to short side tubes blown as just described. It is therefore possible to construct such apparatus as Geissler tubes, small distilling tubes and thermometers, with stems of the German type, etc. We feel sure that small flasks could easily be made also by means of suitable combinations of several oxy-gas burners, though doubtless they would be rather expensive.

Finally, solid rods of silica five or six millimeters in diameter can be made by putting together small masses of prepared silica, or better by pressing together in the flame the softened ends of the fine rods already described.

Notes on some Properties of Vitrous Silica.*—A good many of the properties of silica have already been described by Prof. Boys, but a knowledge of the following, some of which are, we think, now described for the first time, will be found useful:

(1) Vitrous silica is a very poor conductor of heat; hence it is possible to hold a thick rod of silica very close to a strongly ignited zone.

(2) Our colleague, the Rev. H. Pentecost, finds that vitrous silica is less hard than chalcedony, but harder than felspar. Its surface appears to be about equally

THE DOUBLE-FLOWERING PLUM (SHIDARE-UME) AS GROWN BY THE JAPANESE.

hard after it has been heated as strongly as possible and cooled suddenly, and after it has been heated and cooled in the air. Tubes of silica may be readily cut by means of a cutting diamond, and also with a good file of hardened steel.

(3) It has already been stated that cold vitreous silica can be plunged safely into the hottest part of an oxy-gas flame, and that the heating and cooling process can be repeated with impunity. Hot vitreous silica bears sudden cooling equally well. We have repetedly plunged thick rods and large tubes of silica, heated till plastic, into cold water and even into fusible metal below 100°, without any injury to the material, for when afterward cut with a diamond it did not fly.†

On the other hand, threads of silica become rotten when heated to the highest temperature of an ordinary blowpipe.‡ Large objects seem to be affected to a much less degree, and we suspect that this phenomenon may be due to surface devitrification. When silica is in this friable state it can be re-annealed by again softening it in the oxy-gas flame. According to Gaudin, wires of silica heated to a suitable temperature ("rouge-blanc") acquire great cohesion and become very elastic.

We have not yet succeeded in fixing platinum electrodes securely into silica tubes. But we have reason to hope that this may be found to be practicable by the use of kaolin, or some other natural silicate. Meanwhile, it seems possible that they might be soldered into the silica if necessary (see "Laboratory Arts," by R. Threlfall).

We may add that, according to M. Gaudin, emerald gives threads which are even more tenacious than those of silica. — W. A. Shenstone, H. G. Lacell, in Nature.

* See also Gaudin, loc. cit.

† Gaudin obtained similar results with drops of liquid silica.

‡ Gaudin observed a similar phenomenon in the case of fine threads, and so also, we believe, did Boys.

JAPANESE DWARF TREES.

MR. D. G. MITCHELL, once writing of these, well said: "Japanese trees seem under the wings of Japanese buildings, quaint pygmies not 3 feet high, are yet over seventy years old. They are gnarled and twisted, as if they had fought the the winds and caught their picturesqueness of form—as old Oaks catch theirs—by battling with tempests and wintry storms upon the hills. By examining closely the specimens in Japanese grounds one may see traces of the dwarfing process. The leading shoots have been clipped or bent downward; the lateral branches turned in and tied back; lusty limbs twisted and wrenched into quaint postures; marks of the torturing pins, and bands and cuts are still observable; it is a crippled dwarf of a tree made quaint and picturesque by years of struggle. Is there a compensating beauty in them? Not surely as we reckon the beauty of plant growth. But consider that the Japanese, in their horticultural system, have offices for such dwarf trees. With them no homestead is complete without its garden; a few square rods may be all at command, but this area must have its garden treatment, and the gardens are modeled after nature. 'San sui' (mountain and water) is the term which in Japanese describes the cultivator's work. The aim is—within however a limited an area—to present a complete landscape, with rock, valley, plain, water, and mountain. Under such miniature presentment trees and plants must be dwarfed to bear proper relations to the dwarfed valleys and rocks. To such an extent is this copying of nature in miniature carried out that a rocky landscape, with its heights and level spaces and trees, is wrought out, with close attention to proportions within the limits of a great bronze basin. We doubt if cultivators of the West will emulate them in their mimicry of Nature; but they may well emulate the painstaking skill which makes such small successes possible, and the assiduous care and the close study of plant life which are enforced by such arts."

The daimios of Yokohama and Nagasaki are not content with the countless beautiful gems of the plant world with which their favored islands are studded, but they must also have dwarfs and monsters of the vegetable kingdom. They must have pine trees with the best part of their roots leaping up into the air several feet higher than their topmost twigs, or Kakis with their branches so contorted as to resemble tangled masses of cordage instead of the graceful trees which we know them to be. By training their shoots and branches with the utmost patience they are able to produce the most monstrous forms, while by limiting the amount of nourishment which the plants receive within the narrowest possible mark they become dwarfs. Hence, by adopting the latter method of checking their growth, they succeed in producing plants which, although they may be over a century old, are still small enough to live and thrive in a medium-sized flower pot. We must also remember that the climate of Japan is peculiarly favorable to this description of horticulture, and it is doubtful whether this kind of culture could be carried out in hot, dry, sunshiny countries. Of all hardy subjects the Conifers seem to have produced the most successful specimens of dwarf and monsters, either because they are more fitted for this mode of treatment, or because they are more in favor in Japanese gardens. Among the Conifers, again, pines seem to produce the happiest results, and the stem, which is reduced to its very simplest expression, grows at a distance from the surface of the soil, and is supported by a number of simple or branched roots supported by sticks, which float about in the air as if they belonged to it. This system of culture seems to be very widespread throughout Japan, and must be practised by a large number of persons, for such specimens are exhibited by hundreds. Worried literally half out of their lives by ill treatment and starvation, it is not to be wondered at if the size of some of these unhappy victims is wholly out of proportion to their age. It is evident that some means are taken to draw the roots out of the soil gradually, without in any way damaging the rootlets, so as to expose all their rammifications to the air, leaving only a small portion of their extremities in the soil.—C. W. Q.

The illustration shows a particularly fine specimen of the double-flowered weeping plum (Shidare-ume), evidently an old and well grown tree. I saw some of them in Japan, but none so evenly flowered as this one. It is not a common plant; the weeping cherry, which I never saw in England, is much commoner. The plums seem to take very kindly to this kind of cultivation. I dined at a house in Kobe where the only table decoration was an old tree in a square pot, with one long branch covered with flowers.—Alfred Parsons.

DWARF CHERRY TREES IN JAPAN.

These grow well in pots. Repotting, if necessary, should be done when the leaves fall off, being careful not to disturb the roots. If the soil is poor, use a little oil cake and loam, well mixed together. In any case it is as well to apply this mixture when the leaves drop off at the end of October or beginning of November, so that the mixture, is well decayed by the spring, when the tree starts into growth. In spring or summer it can be manured again, but the manure must be well decayed by being watered and put in the sun, so as to be well rotted. In January or February, when the trees are coming into bloom, soak some lentils in water for about a week. When thoroughly soaked, crush them well up, place in a linen bag, together with the liquid drained from them, then squeeze the bag, when there should be a milky substance from same. Remove the earth all round the edge of the pot, and pour a little of this liquid all round. When the tree starts into growth in the spring, if small branches grow out from the other branches, these should be nipped off. Only those which grow from the main stem should remain. These trees are best kept outdoors.—S. Eida, in Gardening Illustrated.

EGYPTIAN MUMMIES OF CHILDREN.

By W. S. Harwood.

Curiously interesting was the conversation which I had one day in the British Museum with Dr. Wallis Budge, one of the famous men of the world in his line, the study of the life and character of the ancient Egyptians. The conversation turned upon the mummifying of little children, a feature of the Egyptian life of surpassing interest. Dr. Budge seemed as deeply interested in the methods of caring for the little children after death as he would have been if considering some dominant factor in the political, social or religious life of this strange people.

Why was it that these old Egyptians gave such attention to the embalming of their little children, so that their bodies would be preserved throughout thousands of years?

Dr. Budge, who has been a voluminous writer upon the mummy, says:

"The preservation of the body was the chief aim of every Egyptian who wished for everlasting life."

So to preserve the body was, in the Egyptian way of thinking, to fit it for the final resurrection, a resurrection which was to unite parents and children in an everlasting life where the current of love, temporarily obstructed by death, would flow on forever uninterrupted, ever broadening, ever deepening, ever satisfying with the enrichment of eternity. At points too many here to enumerate, the Egyptian met the problem of death with the solution of immortality.

As a number of mummies of children are preserved in the Museum in the curious little cases with which they were supplied by tender and loving hands in the long gone centuries, I sought permission to make photographs of them. Considerable red tape must be unwound before you are allowed to make photographs of some objects in the Museum, but no authorities could be more obliging or considerate once you have complied with the regulations. Best of all, they consider it a part of their duty so to aid you that you may get the best possible results, and to this end I was given the attendance of an expert from the photographic department, eager to suggest anything that would facilitate my work.

The more one comes to study the subject, the more the beautiful nature of it appears, the less is seen of that which might at first thought seem disagreeable or

MUMMIES OF CHILDREN IN THE BRITISH MUSEUM.

distasteful. This preparation of the dead for the future life was not a gruesome thing; it was a deeply religious act, as deep, to the Egyptian of the far days, as any ceremonial pertaining to the last hours of our own dead. These dearly loved ones whose lives went out amidst the strange scenes of the land of the Nile were dead but for a time—their real life was to begin when there should be no further need for cerements. The more one studies these mummies themselves, the more one must be impressed with the steadfastness of the belief of the people in a higher life. We encase our dead in caskets and tombs, or burn their bodies and urn their ashes; the Egyptian, rich in his poetry and fine in his fancy, fitted his dead for the resurrection as to him seemed most natural and sweetest. We differ with him, our forms differ from his; we seem to have caught a more beautiful thought of the resurrection; but, I doubt not our burial or incineration might have seemed to some of Egypt born barbarous, mayhap baneful. Now and then two mummies have been found in the same case, the mother and her tiny baby, dying soon after birth with the parent. There seems something very beautiful in the belief that the two shall be reunited after their bodies have seen the last of earth.

Many were the curious things which Dr. Budge told me; or, if he had not the time to recount them, he would refer me to some one of his many works for the material. Sometimes the little children were preserved in honey, a preservative of tested value. Their bodies have been found in great jars of this liquid in most excellent condition, even though many centuries had elapsed since their death. Others were preserved in costly spices and gums, while some were kept by means of bitumen. The bodies of the poor were preserved in salt and hot bitumen, sometimes by means of salt alone. One of the odd fancies, both with grown people and children, was to tan the face with some preparation which left the skin in a remarkably life-like condition as to texture, and then to gild it with a gilt which outlasts the centuries. So some of the mummies are found, the contour of their faces capitally maintained. Others, as you may see in many of the scores of examples in the Museum, bear upon the outside of the case the portrait of the deceased done in some manner of pigment which wonderfully preserves the original tints.

It is perhaps not generally known that a great trade in mummies sprang up in the middle ages among a lot of irresponsible peddlers, who went up and down Europe with their wares from the tombs. These charlatans pretended that various diseases could be cured by means of these mummies, and, when the supply fell short, they were wont to manufacture mummies to order and proceed with their quackery. It is recorded that they even compounded so-called medicines from the mummy remains.

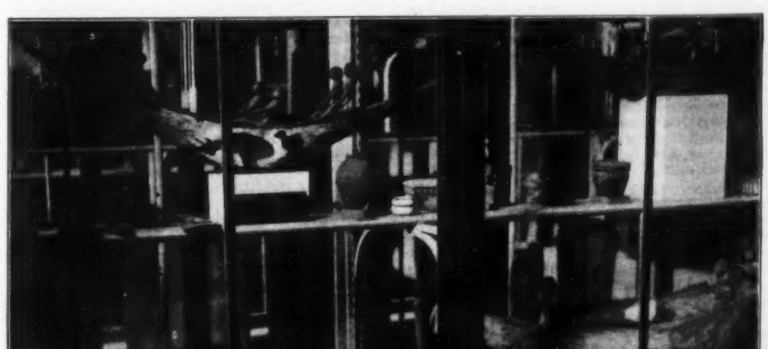
Any consideration of the mummifying of little chil-

MUMMY OF A GREEK WITH PAINTED PORTRAIT.

dren would be incomplete which did not take into account the similar treatment of the cats of Egypt, and the Scientific American of the current week discusses the subject.

In one of the large cases in the second Egyptian room of the Museum, I found some of the child mummies, and photographs were made from them quite easily. The case of one of the children, from a family of high rank is made in the form of the god Osiris. The face is gilded and in the hands are the crook flail, symbols of dominion and sovereignty. In the central figure in the photograph the mummy is of a little Greek child, with a gilded cartoonage for the head and shoulders. Painted scenes are depicted on the bandages which enswathe the lower part of the body, showing the child offering sacrifices to the gods, with one picture in character symbolical of the Judgment. Just above the feet is the funeral boat, showing the little child lying upon the bier. She bears in her hand a bunch of red flowers, which belongs to the funeral customs of the East from the very earliest history.

The cartoonage referred to is composed of twenty to



ANCIENT MODELS OF BOATS FOUND IN EGYPTIAN TOMBS.

thirty layers of fine linen, tightly pressed together and glued, so that it forms a stiff, pasteboard-like material. This is then covered with stucco, and on the stucco the gilding or other ornamentation is superimposed.

Frequently in and about the tombs, where the mummies are preserved, models have been found of the little boats which are represented on the covering of this little child's mummy. The boats have their crews, also, tiny people, who stand in various postures on the deck, or who are engaged in the actual work of propelling the boat.

It was the ferry of the dead, the destination being the tombs among the mountains on the western banks of the Nile. Some of the groups of figures appear to be talking to the dead, others are carrying on some sort of pantomime, others are seated at the banks of

LATE MUMMY, 100 A.D., SHOWING FIGURES OF THE GODS.

oars. The body of the dead usually rests some distance apart, in the stern of the boat. Though the wood shows some sign of decay, it has really been quite wonderfully preserved. The figures are also of wood. One might easily find fault with them from the anatomical or artistic point of view, but they are, nevertheless, very human little beings, and they admirably depict the enterprise in which they are engaged. The bodies are, perhaps, eight inches in height, and the longest of the boats will not measure more than two and one-half feet in length.

Dr. Budge fixes the date of the first embalming at least as far back as 4500 B. C. The word mummy itself finds its origin in the custom of embalming the dead, being derived from the Arabic word mumia, or bitumen, the substance so much in use in the preservation of the bodies. There was a guild in ancient Egypt organized for the purpose of embalming or mummifying the dead. It cost but very little to prepare the bodies of the poor, but to do the service for one of rank and wealth involved an expense of about twelve hundred dollars. Properly to enswathe some of the bodies required about one-fourth of a mile of linen bandages. Before the bandages were applied the body must have lain in natron for seventy days, though Dr. Bunge calls attention to the fact that the biblical account of the embalming of patriarch Jacob, noted in Genesis, placed the period at forty days. Some of the mummies had an outer shroud of fine linen dyed red, over that a layer of porcelain, inlaid with figures of the deities of the dead. Sometimes portions of the Book of the Dead, a liturgy, composed

for funeral occasions, were inscribed on the outer coverings.

It was the custom to encase the body when the mummifying finally was all complete in a wooden coffin, which was conveyed to the tomb in which the dead were to await the day of resurrection; funeral services were of the most solemn character; prayers for the dead, composed with the belief that their recital would enable him "to overcome all ghostly foes, would endow his body in the tomb with power to resist corruption, and would insure him a new life in a glorified body in heaven," were chanted by the priests, and the utmost importance was attached to everything which pertained to the last offices of the living for the dead.

You may see in the Museum many articles which were taken from the tombs, articles which were thought to have particular value for the departed. Many of these were things which the dead person had highly prized in life. Ready at hand for the last act of the tomb, the resurrection, were alabaster vessels filled with ungents for the toilet or with wines for the refreshment of one brought back to life after the thousands of years of abstention. Foods, too, were placed on tables near the bier, while little figures of limestone, marble, granite, alabaster, wood, porcelain, or even wax, were left near at hand. These were to do service for the dead in the underworld, in case labors were called for, and sometimes the hands would hold a hoe, a cord, or a basket, to show the character of work to be performed.

On no point was Dr. Budge more emphatic than on the belief which these ancient people had in a future life, on nothing is he more definite than in his statements as to the religious side of the Egyptian character. They believed, he says, not only in the one great supreme power, "which made the earth, the heavens, the sky, men and women, animals, birds and creeping things, and all that is and all that shall be," but in a number of beings or existences, which they believed possessed something in the nature of God. The Earth, Sun, Moon, Stars, Light and Darkness, the Inundation, the Year, the Seasons and the Hours were among them. The doctrine of a life beyond the grave, an eternal existence, was enunciated at all periods with the greatest clearness. To the soul they gave the name "Ba," depicting it in the form of a human-headed hawk. The complete man was composed first, of a corruptible body; second, a spiritual body; third, a heart; fourth, a double, a sort of a second man, which, if it choose, could inhabit a statue of him should his friends erect one to his memory; fifth, a soul; sixth, a shadow; seventh, an intangible shining case, or spirit; eighth, a divine form; and, lastly, or ninth on the list, a name.

Not to follow this point too far for the purposes of a paper such as this, it may be said they believed the spiritual body began its existence as soon as the physical body was laid in the tomb. I do not know that the future state of the Egyptian of the ancient days has ever more beautifully been set forth than in these words of the famous Egyptologist above referred to:

"In Heaven the dead eat bread which never becomes stale, and drink wine which grows not musty; they wear white apparel, and sit upon thrones among the gods who cluster around the tree of life near the lake in the Field of Peace; they wear the crowns which the gods give unto them, and no evil being or thing has any power to harm them in their new abode, where they will live with Ba forever."

THE ECLIPSE AT WADESBORO, N. C.

The correspondent of The New York Sun sent the following admirable report from Wadesboro, North Carolina on the day of the eclipse (May 28):

What the eclipse will reveal of the mysteries of the sun, what the observations here taken will add to the sum total—a meager sum total at best—of the world's scientific knowledge on the subject are secrets as yet locked up in the undeveloped photographic plates which were made in the ninety-one seconds when the moon shut off all the direct solar rays. So far as the visual observations were concerned the general opinion among the scientists here is that the most remarkable feature of them is their barrenness. Prof. Young of Princeton, who had hoped to identify the coronium line of the corona spectrum with the 1474 line of the solar spectrum and thus confirm his observations made in 1870, not only failed to see the coronium line in the corona spectrum, but also failed to see any lines whatever. He was disappointed and frankly confessed himself to be.

"I feel like getting into a well and staying there," he remarked to one of the other observers who was speaking with him on the subject.

Then again the corona was faint and the white prominences which have been one of the interesting features of other eclipses were faint or entirely wanting. The corona was paler and dimmer than on other occasions. The corona streamers, wavering sheets, apparently of flame, which shoot out thousands of miles from the sun's surface, were less active than they have been in other eclipses which have occurred at periods where the solar spots were nearer the maximum.

So all things considered, it was entirely a neutral and non-resultant eclipse, so far as the observers with telescopes were concerned. Fortunately, however, this does not tell all the story. The photographic plates have yet to relate their history of the eclipse of 1900. Upon what they will reveal the scientists are placing a good deal of hope of enlightenment. The strides made in the art of photography of late years have been anxiously watched by the astronomers, and now came the time when the very latest discoveries and achievements could be applied to seizing and holding for future study all that the phenomenon of an eclipse had to reveal. The preparations for this feature of observations were never before equalled in the history of eclipses. Without an exception the photographic machines worked almost to perfection. Of course, the plates have not been developed as yet, and will not be for several days to come. Until that is done it is an open question whether the eclipse of 1900 will prove one of the emptiest or one of the fullest of results of any observed within a considerable time. So the attitude of the scientists is that they are disappointed as to their visual observations and hopeful as to the records made by their photographic appliances. With the laymen, however, it is another matter. For them it was a spectacle pure and simple and if the thousands of people who saw it along the belt of totality, fifty miles wide, were impressed with it as were the hundreds who saw it here in Wadesboro, it is one that will not pass from their memories for many a long year to come.

So far as the weather conditions were concerned there was absolutely nothing left to be desired. All the astronomers, to whom a clear or cloudy sky meant so much, are enthusiastic over the way the elements favored them. They slept but little last night; some of them hardly slept at all. There was uneasiness yesterday afternoon over certain signals the sky was hanging out. There was a vapory aspect overhead and half way up from the horizon to the zenith there hung all around the heavens dim outlines of watery looking clouds. Some of the professors looked gloomy and shook their heads; but after sunset the aspect of things changed. The watery look melted and the sky grew to a hard, firm blue and the stars above shone with almost the brilliance of a frosty midwinter night. The spirits of the scientists visibly rose. As midnight passed and the promise for a clear sunrise still held good and strong, they exchanged cheerful greetings and congratulations with one another. Then some of them went to bed and slept in cat naps until from 4 to 5 o'clock in the morning, when they were called.

The promise of the night before was more than made good. The sun swung up above the hills, nearly forty miles away on the rim of the eastern horizon with a clear, reddish glare that soon had all the morning mists in the valleys scattered and on the run. The very first of its rays that hit Wadesboro fell full on the Princeton battery of scientific artillery that was already unlimbered and ready for action in the wheat field on the steep hillside of Captain Stanley's place. The celestial artillery of the Yerkes Observatory and the Smithsonian Institution were masked down in the gulley on the Leak place and the sun was well above the hills before its rays found them out. Up on Carr's Mount were still other works of the enemy. At 7:36:10, Sol was due at a certain point in the heavens and toward that point the combined forces of science converged, there to hold him up and wrench from him every secret that could be dragged from him at a 92,000,000-mile range.

Not only was the sky absolutely cloudless, but it seemed for a time that there was to be an entire absence of wind also, and that is an important factor in some of the delicate observations that were planned. By 7 o'clock, however, a gentle wind began stirring from west-southwest, which, before totally was over, had developed into a steady breeze of considerable volume. Its only effect on the observations, so far as is known, was upon the movement of the so-called shadow bands. It happens that just a few seconds before totality begins, and an equal number of seconds before it ends, curious band-like shadows are seen chasing one another across any light-colored surface that may be spread upon the ground. At the Yerkes, Smithsonian and Princeton observatories, and by the side of the ten-foot platform on Carr's Mount, which Prof. Phillips, principal of the Normal School at West Chester, Pa., and Prof. Quinby, of Philadelphia, had erected, white strips of canvas were stretched on the ground, and an observer was stationed by them to note the shadows, the time they began, the time they ended and particularly their direction In speaking of the result of these observations Prof. Quinby said:

"About the only interesting visual observations that were clearly defined were of the shadow bands, and, curiously enough, at every place where they were observed they were different; that is to say, they moved in different directions."

This queer result was attributed to the wind, but just how the wind made it was not made quite clear to the lay mind. But the people, who were looking at the eclipse as they would at a yacht race, were not interested in shadow bands or coronal streamers or reversing layers or any of the other technical mysteries. They wanted to see the little black spot come on the northwest corner of the sun, to see it grow to a dark crescent, to see it eat its way through the sun until the sun itself became a mere silvery thread of a new moon crescent, and then finally disappear as a shining disk altogether. They wanted to see the strange, unearthly darkness settle down upon the land, to feel the creepy chill in the air that came with the gradual shutting off of the sun's warming beams; to see the chickens crow and go to roost for a minute and a half and then get up, with the roosters crowing to greet the dawn of the new day that followed a night which was sure to go down in chicken annals as a record breaker for shortness.

That is what the people wanted to see and hear and feel, and it was upon Carr's Mount that they went to do it. In addition to Prof. Phillips and Prof. Quinby there were on this hill also the nineteen members of the senior class of the South Carolina State Military Academy, who, with Prof. Bond in charge, had come all the way from Charleston to observe the eclipse. Fine brown-cheeked young fellows they were, too, and as erect and trim and neatly dressed in their gay blouses and white duck trousers as the West Pointers themselves. It has nothing to do with the severely scientific respect of the sun's occultation, but it may as well be mentioned, perhaps, that there were a score or so of girls up on Carr's Mount also. They had come over on the big excursion from Charlotte and were altogether so blooming and so radiant in their bright flower-bedecked spring attire that their prettiness in several distinct instances approached a point where really it was not quite fair for them to be around where trim manly young fellows had to be squinting through telescopes and doing mathematical things with square roots and cubes and the Greek letter pi, with a microscope or two hanging on its starboard quarter. It was, indeed, quite a study in contortion of the facial muscles to note how those young men gimleted one eye into the little end of a telescope and tried to make the other have some self-respect and quit squinting after those insolently pretty Charlotte girls.

As a matter of fact, one reason why the excursionists went to Carr's Mount to see the spectacle was because they were shut off from anywhere within gunshot of the Princeton, Yerkes and Smithsonian observatories. Even the streets leading toward the places where the learned men were at work were barred to all loitering curiosity seekers and the scientists were absolutely unhampered and freed from even the annoyance of being stared at as they worked.

But upon the hill with its splendid panorama spread out in a great circle from sixty to eighty miles in diameter it was free for all. It was the orchestra and dress circle of the big show. The observatories were the private boxes. There was a reverse order of things so far as the gallery was concerned. Instead of being above, it was down below at the foot of the hill where the darkies gathered in groups of men, women and pickaninnies and took observations on their own account. Many of them had smoked glasses, although there was not enough contrast to make the fact apparent when they held them up to their faces.

Upon the hilltop more than two hundred persons were assembled, most of them intent upon seeing the shadow of the totality and the ensuing path of light as the first bright edge of the sun was uncovered. This is usually one of the most impressive features of a total eclipse. It can only be seen for an instant, for the shadow moves at the rate of 1,500 miles an hour. Where the observer commands a wide stretch of country, as was the case here, this flying wave of darkness is described as creating an impression overwhelming and uncanny enough to hush even the most frivolous observer. But even the shadow of totality failed us here. At least nobody saw it, although hundreds were straining their eyes toward the southwest, whence it was due to come. Either the haze that hung low down upon the surface of the earth in that direction or some peculiarity of atmospheric conditions prevented its appearance. Neither was the oncoming light wave observed.

This was in keeping with the entire character of the eclipse. It was a tame one for the observer with either the naked eye or a telescope, and yet even a tame eclipse is something not to be forgotten. The two observers, Prof. Phillips and Prof. Quinby, made a little speech to the people gathered in the vicinity of their raised platform on the hill. They earnestly requested that nobody talk during the interval of totality as it would disturb them in their observations. The request was unnecessary. Nobody wanted to talk or did talk save in subdued, awed tones during the solemn interval of strange, unnatural twilight while the ninety-one seconds of total observation were counted out.

The silence had grown upon the people with the gathering darkness. The air for fifteen minutes before the totality was completed had been growing sensibly colder. The breeze from the southwest, which had been an agreeable relief in the heat of the blazing sunlight became distinctly chilly. From down in the valley and in the barnyards in houses nearer by the crowing of roosters could be heard. The calls of birds whose notes are only heard at twilight and dawn came from far and near. It was a strange reddish light, such as neither sun nor moon in normal conditions can give. All around the magnificent sweep of horizon was a curious tawny glow, while overhead the sky took on the deepest hue of night.

Close to the sun, with its corona stretched out in arrow-like bands of soft white light on either side, the planet Mercury, which is so near the sun that it rarely is seen, save for a moment or two before sunrise or sunset, shone out bright and clear. A little to the north, and farther down toward the horizon, Venus glowed almost as brightly as on a dark night. Aldebaran, it was thought, would appear, but did not, and such other stars as were seen were so dim and uncertain that you could hardly be sure they were there.

On the ground at your feet were queer shimmering shadows coming and going in swift vibrations, as you may see the heat waves trembling in the air when the thermometer is in the nineties.

PROF. LANGLEY'S SUMMARY OF RESULTS.

Prof. Langley, of the Smithsonian Institution, gave out for the press this evening the following summary of the observations which he and his corps of scientists and assistants made:

"The total eclipse of the sun was observed here under a cloudless sky. All the observations planned by the Smithsonian party were carried out without miscarriage so far as can now be determined. Numerous photographic exposures were made with a 135-foot focus telescope on the reflected image of the corona, and to obtain a flash spectrum independently of a 38-foot focus telescope, pointed directly on the sun; while an automatic apparatus was used to determine with precision the times of the four contacts.

"Five cameras were employed in the study of the outer corona and in the search for intramercurial planets. The bolometer was used to-day for the first time in connection with an eclipse of the sun, and by its aid the heat of the corona was successfully observed, probably for the first time also.

"The shadow bands were seen and photographed under favorable conditions, and meteorological observations were conducted. Visual observations and sketches were made, and the observations will, it is hoped, prove successful throughout. S. P. Langley."

For some reason, as yet unexplained, the Smithsonian time signals did not work. The Princeton people had been looking at the first contact of the eclipse for five seconds before the Smithsonian observers found out that an eclipse was on. The bell which was to announce the instant of contact was just that length of time behind the procession.

The Yerkes Observatory people also depended upon this bell and some mishaps might very well have happened in consequence of the error. As it was, Prof. Barnard's last photograph with the big 62-foot camera was caught with a little corner of the uncovered sun appearing in it. The fact, however, will not materially damage the picture. In all, seven pictures were taken with the Yerkes monster camera. They are on plates 25 by 30 inches, and should show the corona and corona streamers even better than the pictures taken from the Smithsonian 135-foot camera. In the latter the same size plates are used as in the Yerkes camera, and the body of the sun will come so much nearer to filling them that there will be scant room for the streamers. There will be compensation for this, however, in the greater detail given of the corona proper.

Prof. A. C. Child of the Smithsonian said that in the north polar region of the sun he saw about fifteen

streamers of even and regular structure and with firm bright centers. In the south polar region the streamers were rolling from a point not near the center of the sun, but near its limb. They were of somewhat finer structure than those in the north polar region, and some of them crossed. On the left limb of the sun there was a very perceptible eruptive solar prominence with a detached fan and extending about one-tenth of the diameter of the sun. This was of a deep scarlet red in color. The corona was bluish green.

Mr. Nevil Maskelyne, one of the observers of the British Astronomical Association, took 600 cinematograph photographs of the eclipse, 350 of which were during totality.

None of the observers has as yet worked out the exact times of the different contacts, but in a general way it is established that the actual hour of the eclipse was about two seconds behind the computed hour, which for the first contact was 7 o'clock 36 minutes 10 seconds. There is still some confusion in the records from the five seconds delay on the part of the Smithsonian observers in sounding the signal bell.

TWELFTH CENSUS OF THE UNITED STATES.

By GEORGE E. BOOS, Supt. of Printing.

THE newspapers of the country have, from time to time, published articles upon the work of taking the Twelfth Census of the United States and its newly acquired possessions. Suffice it to say, however, that the preparatory work in this connection is so far advanced that a few days only will be necessary to find the enumerators fully equipped with the required blanks and instructions to perform their duties with accuracy and within the time specified by law. In this connection, I wish also to say, that the public has no conception of the enormous quantity of printed schedules, blanks, circulars, envelopes, cards, etc., that will be distributed to the enumerators and canvassers to facilitate them in their work of gathering the statistics relating to the population, manufacture, agriculture, and the numerous other industries that will be included in this census.

At this age of civilization, when it is a rare thing to find a man, woman or child over the age of eight years who cannot read or write, you will readily understand why so much literature and printed matter is needed. It is the intention of Hon. W. R. Merriam, the Director of the Census, to leave no stone unturned in securing a concise and accurate count in all the branches named, and he thinks this can best be reached through the medium of printer's ink.

I will not at this time, however, go into details, as the subject is too broad to do it justice within the allotted space. The object of this article is to direct your attention, or rather to enlighten you, upon the modus operandi of the use of the card record (of which a cut appears below in reduced form), for ascertaining the population and other information incident thereto. There will be eighty millions of these cards—one for each living inhabitant.

These cards are being made at the Union Paper Mills, New Hope, Pa. Special machinery is constructed for the production of this stupendous work. The paper is made in one large roll, then this roll is cut into four smaller rolls and placed on two "Kidder" printing presses, which print, number, cut and clip 14 cards in one impression at an average rate of 600,000 cards per day, requiring 134 days to complete the job, provided there are no delays from accidents. The making of these cards requires the most careful attention, and a constant inspection is had during the progress of their production. They are made of rope manila stock, and must be of an almost even thickness, not to exceed ·0075 and not less than ·0065 inch, being 6⅝ inches long by 3¼ inches high, with the lower corner cut off.

Each card is fed through several devices—the first, a keyboard punch, and is perforated by symbols just as the schedule represents each individual that is taken by the 52,000 enumerators, giving his district, language, color, literacy, sex, months unemployed, age, occupation, conjugal condition, birthplace, etc. This work will be done by an army of clerks acting in the capacity of punchers, tabulators, and sorters.

The enormity of this undertaking can hardly be realized. Each card is handled a number of times. These eighty millions, if piled on top of each other would reach a distance of over nine miles. It became necessary to invent the best labor and time-saving device that brain could produce.

The following is a description of the three principal parts of these almost human machines:

KEYBOARD PUNCH.

The keyboard punch is about the size of a typewriter tray, having in front a perforated punch-board of celluloid. Over this keyboard swings freely a sharp index finger, whose movement, after the manner of a pantagraph, is repeated at the rear by a punch. The movement of the punch is limited between two guides, upon which are placed thin manila cards 6⅝ inches long by 3¼ inches high, with the lower corner slightly clipped. The keyboard has twelve rows of twenty holes, and each hole has its distinctive lettering or number that corresponds to the inquiry and answer respecting every person. Hence when the index finger is pressed down into any one of these holes the punch stamps out a hole in the manila card. The keyboard is scientifically grouped, and it is very readily learned. For such inquiries as are answered by one of a very few possible classes—sex, for example, which recognizes only two parties in the State—the answer is simply "male" or "female," or "M" or "F." So, too, in regard to conjugal relationships, where the answer would be either single, married, widowed or divorced. These holes may easily be found in "D." "Wd." "Mr.," or "S." Where, however, the answers would cover a wider range of classification, as in age, running from 1 to 100, recourse is had to a combination of two holes, the first indicating a group, as from 25 to 29 years, while the second hole designates the detail single year in that group.

To assist the clerks in memorizing the keyboard for punching, classification lists are used, which show the combinations used to designate each occupation. At first this looks a little complicated, but after all, the symbols "come easy" with each lot of schedules.

How Birthplace is Recorded.—The birthplace is recorded by punching first the general nativity, either "N" for native or "F" for foreign. The particular country of birth is recorded by punching one of the holes indicated in the lower lines of the symbols for birthplaces on the card. Thus "Sc" for Scotland, "Ch" for China "Hu" for Hungary, "Fr" for France, etc. For example, "Fr" being punched in connection with "F" for general nativity, would mean France, but the same hole punched according to the upper symbol, "Sc," in connection with "N" for general nativity, would mean South Carolina. By this simple means the birthplaces are indicated in half the space that would otherwise be required on the card.

A clerk punching the card for an agricultural district has but few symbols to bother about. It will thus be seen that these innocent combinations are no more burdensome on the memory than the details of a typewriter keyboard. On the contrary, they are vastly interesting. That the work of punching becomes as easy as any other task requiring ordinary intelligence is shown in the fact that the estimated average of 800 cards per day per clerk is the actual average. It is stated that some of the more expert punchers, working seven hours, have done 1,100 cards, with an aggregate of 18,700 holes, each card having 17 holes in it that relate specifically to the individual whose life history is thus condensed. After the cards leave the punching clerks, they are kept in their enumeration districts, and they have now to be further punched to show the exact locality they belong to, i. e., the civil division of which the enumeration district formed a part. For this purpose the space of about 1 inch across the left hand end of the card is used, no portion to the left of this line being punched on the keyboard punch. This space is further divided into 48 squares, in the combinations of which every enumeration district can be recorded, and it is perforated by means of the "Gang Punch." The combination for any given enumeration district is arranged in this, and then all the cards of that district are passed through. From six to twelve cards can be punched at a time, hence the name, and pressure may be applied by either the hand or foot. When this is done, the cards are complete.

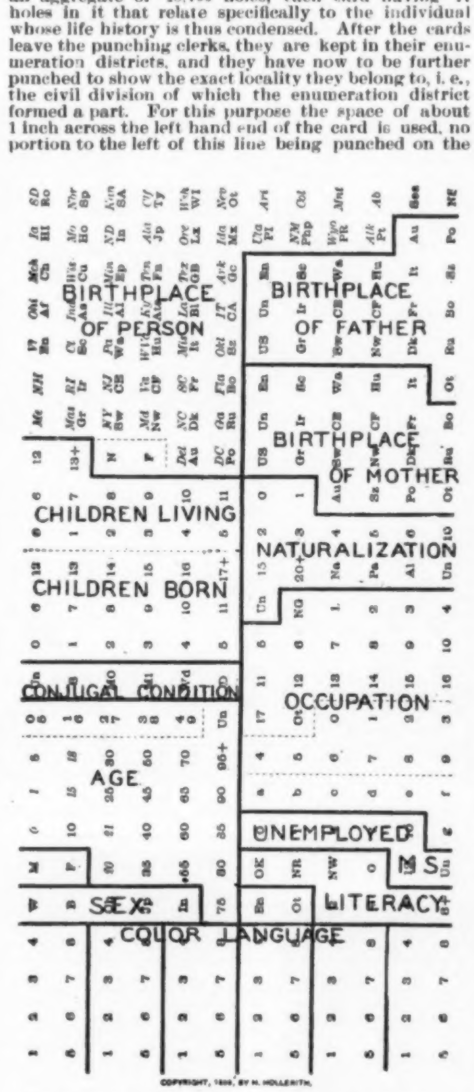


ILLUSTRATION OF TABULATING CARD.

This card is blocked out in nineteen (19) divisions indicated by black lines. The first relates to "Birthplace," the one below this on the left (read downward) indicates "Children living," and "Children born," "Conjugal condition," "Age," "Sex," "Color." The space on the right below the first division indicates "Birthplace of father," and next below this "Birthplace of mother." Thus, "Naturalization," "Occupation," "Months unemployed," "Literacy," "Language," and the last six divisions at the bottom of the card indicate "Enumeration District."

Familiarity with combination.—So familiar do the clerks become with the position of the holes in these cards, they can read them off at a glance. As a means of verifying, however, a "reading board" is provided for that purpose, the same size as the card, and having also each of the 240 abbreviations in a quarter-inch space, so that when a perforated card is put on this templet, the abbreviation will show wherever a hole has been punched.

These wonderful little cards have now come to stand for over 70,000,000 people. Each card is not only full of holes, but has its number, and is ready for the next stage of treatment, when each of the holes will tell its story in just the same manner as the perforations in an organette strip will cause certain notes of music to be played. The cards are stacked up on end in boxes, measuring 20 by 7 by 3¼ inches, each box taking 2,000 cards. In front of each box is a label stating its contents.

THE ELECTRIC TABULATING MACHINE.

The Electric Tabulating Machine consists of three main parts, namely, the press or circuit closing device, the dials or counters, and the sorting boxes. The press consists of a hard rubber plate, provided with 316 holes or pockets, the relative positions of which correspond with those of the holes in the keyboard and gang punches. Each of these pockets is partially filled with mercury, and they are thus in electrical connection, when the circuit is closed, with the binding posts and switchboard at the back of the machine. Above the hard rubber plate swings a reciprocating pin box, which is provided with a number of projecting spring-actuated points, so hung as to drop exactly into the center of the little mercury cups below. These pins are so connected that when a punched card is laid on the rubber plate against the guides or stops and the box is brought down, all the pins that are stopped by the unpunched surface will be pressed back, while those that correspond with punched spaces pass through, close the circuit, and count on the dials. The circuit is broken first through platinum contacts at the back of the press. In this way no difficulty is experienced from the oxidation of the mercury from the spark, as would be the case without this precaution.

The dials in front of each counter are 3 inches square, and, as now made, consist of paper ingeniously coated with celluloid, insuring a smooth, bright, clean face. Each dial divided into 100 parts, and two hands travel over the face, one counting units and the other hundreds. The train of clockwork is operated electrically, by means of the electro-magnet, whose armature, as it moves each time the circuit is closed, carries the unit hand for one division, while every complete revolution actuates a carrying device, which in turn causes the hundred hand to count. In this way each dial will register up to 10,000. A noteworthy feature of these ingenious little dials is that they can quickly be reset at zero, while they are also removable and interchangeable. The electrical connections are made simply by slipping them into the frames and clips.

SORTING BOX.

The third element in the system is the sorting box, which is divided into numerous compartments, each of which is kept closed by a lid. The lid is held closed against the tension of springs by a catch at the free end of an armature. If the circuit is closed, by the press on the machine, through an electro-magnet, the armature is pulled down, releasing the trigger of the lid, which is at once thrown up by the spring, and remains open until flipped back by a slight touch of the operator's hand. The connections with the machine are made by means of the short cable at the left of the sorting box. Wires are attached to binding posts on a small board, but a minor change has been made by which the board is pushed in between contact clips in the machine, thus saving valuable time by obviating the necessity of screwing and unscrewing so many binding posts whenever it is desired to remove the box for any reason.

If it is desired to know in a given enumeration district, or all of them, the number of males and females, white and colored, single, married, widowed, etc., the binding posts of the switchboard corresponding with these data are connected with the binding posts of the dials on which these items are to be counted. If it is also desired to assort the cards according to age groups, for example, the binding posts of the switchboard representing such groups are connected with the clips into which the sorting box plug fits. The circuits being prepared, when a card is placed in position in the press and the handle of the pin box is depressed by the operator, so that the circuit is closed through each hole in the card, not only will the registration be effected on the counting dials, but the sorting box that has been selected for a given age group is opened. The operator releases the handle, removes the card deftly from the press, deposits it in the open sorting compartment with the right hand, and pads the lid down again, at the same time bringing another card into position under the press with the left hand. It is done much more quickly than it is described. When all the cards in the case of any district have thus gone through the press, the record taken from the dials will show the number of males, females, white, colored, etc., while the cards will have been assorted into age groups.

The machine automatically throws out any card that is wrong. Suppose, for instance, that the age or sex has not been punched. Where there should be a hole for the plunger pin to go through, closing the circuit, the card is intact. The circuit is open, and the monitor bell just to the left of the press refuses to give its signal of correctness.

The mechanism of these three devices is the wonderful invention of Dr. Herman Hollerith, of the city of Washington, D. C. Many of these machines will be required. The building and adjusting of these machines is now in progress by the Tabulating Machine Company, under the personal supervision of Dr. Hollerith, who contracted with the government to furnish and maintain the efficiency of these mechanical wonders for the taking of the Twelfth Census of this country.

It is stated that the operation of these machines will effect a saving of 50 per cent. over the old method of tabulating and counting our people, besides a great deal of time, which is very essential in the taking of the Twelfth Census, which is in part to be completed in twenty-five months from the date of commencement.

Fruit Trees in Saxony.—Vice-Consul Murphy writes from Magdeburg, April 9, 1900:

According to a report published in the German Agricultural Press, the fruit trees in the province of Saxony, Prussia, were carefully counted in the years 1897–1899, and it was found that they numbered 12,793,461. Of this total 52·7 per cent. were plum trees, 19·6 per cent. apple trees, 16·8 per cent. sweet cherry trees, and 10·9 per cent. pear trees. Estimating the value of each tree at 8 marks ($1.90), the fruit trees of the province of Saxony represent a capital of 100,000,000 marks ($24,000,000).

EGYPTIAN EXPLORATION.

THE work of the Egyptian Exploration Fund at Abydos during the past winter was described by Prof. Flinders Petrie in a lecture at University College. He said that during the past four years a large quantity of early remains had been found by M. Amélineau in some large tombs at Abydos, but nothing was proved as to their date, and opinions widely differed. At last English work was permitted there, and within two or three months the historical questions were settled, and a large collection of material of the First Dynasty was obtained from the same ground that had been already ransacked. The first dynasty of Egyptian kings had generally been looked on as more or less mythical. Now we are able to handle the royal drinking bowls from the palaces, to compare their art and their carvings, to criticise the posthumous respect paid to each king, and to feel much more familiar with the daily life of the age than we could with our own Saxon kings. All this had come about through the careful study of three or four insignificant-looking lumps of black mud. The royal wine-jars were sealed by the officials, and in most cases only bore the hawk name or Ka name of the king, which was not recorded in the lists of kings. Hence we were still in the air historically. But one or two seals of each king bore both his names, and from these the actual tombs of the fifth, sixth and seventh kings of the First Dynasty, named by Manetho, Usafais, Miebis and Semempses, had been identified. Other royal tombs of the same group were those of the other kings of the First Dynasty. This discovery had also, by the style of work and the position of the objects of King Aha, led to this king's being certainly identified with Menes, the founder of the Egyptian monarchy. Thus the tablet found by De Morgan in the tomb of Aha proved to have been correctly interpreted by Borchardt. We were now in a position to form a correct appreciation of the whole of the First Dynasty between 4,000 and 5,000 B. C. The art, which was rude and archaic under Menes, rose to its best point under the luxurious King Den-setui, the fifth of the dynasty. His tomb was paved with red granite and richly furnished with cups of crystal and beautiful stones, bearing his name in large finely cut hieroglyphs, while no fewer than twenty tablets of ivory and ebony carved with inscriptions were known of from his tomb. The latter kings showed less sumptuousness, but a more general habit of inscribing the objects of the palace and the tomb. The principal classes of antiquities obtained in the past winter were: 1. The great tombstones of the kings, one of Merneit, a king as yet unknown, and one of Qa, the last king of the dynasty; 2, the private tombstones of the royal domestics, of which fifty had been obtained, one in particular giving all the official titles of a major-domo of this age; 3, the fine stone drinking bowls and platters, portions of several hundred dishes of fine stones, to say nothing of the abundant alabaster and slate dishes, about sixty of which bore royal inscriptions; 4, the impressions of seals on the closing of the wine jars, of which eighty-eight different inscriptions were now drawn; 5, the labels and tablets of ivory and ebony, of which parts of thirty had been found with inscriptions; 6, the innumerable pieces of carving in slate, ebony, ivory and stones. After the selection of a few—the most valuable—pieces for the Cairo Museum, the rest were all on the way to London, and would be exhibited at University College in July, as usual. The publication of these results in sixty-eight plates would appear before then. —The Architect and Contract Reporter.

THE CONSTRUCTION OF STONEHENGE.

IT would not have been impossible for the ancient Britons to have moved and to have erected large blocks of stone for the construction of Stonehenge. Such stones, after having been shaped and dressed, may have been transported by a machine similar to that mentioned by Vitruvius, whereby the stone being surrounded in a cylindrical framework became the nucleus of a roller, around the ends of which ropes were coiled; and a drawing power being applied to the end of each rope caused it to unwind, and thereby to set in motion the roller. This contrivance for the transport of a great weight over rugged ground possessed mechanical advantages over any wheel carriage: First, because the surface in contact with the ground being broad, is not liable to sink in soft places; secondly, because there is no friction of axle; and thirdly, because it contains a mechanical purchase which doubles the power applied, the advance of the roller being evidently only half that of the moving power. The stone being thus conveyed to the spot fixed upon for its erection, we may suppose that an excavation was ready to receive it, and that the excavated earth would form a bank. The roller would then be dragged along the sloping side of this bank until the lower end of the stone was opposite to the spot on which it was destined to stand, and from this inclined position it may have been raised to upright by ropes attached to it, and passed over two pair of 30-foot poles inclined in a direction contrary to that of the stone itself. Then by a power applied to these ropes, the stones may have been securely raised to perpendicular. After the uprights had been thus fixed in the ground the impost may have been raised by a succession of wooden blocks or long billets being placed underneath the stone, the ends of it being alternately elevated so as to admit a block; and if we suppose the stone to bear upon these blocks for one-third of its length, only the remaining two-thirds would be in equilibrium with each other. Thus by means of a long pole or poles lashed firmly along the upper surface of the stone the weight to be swayed up at each effort would not be that of the whole stone, but of one-third of it only, the upper and lower thirds being (as before said) in equilibrium. When the impost had been thus raised to a level with the uprights it was necessary to move it laterally into its place, which may have been done by so placing the uppermost blocks as to form an inclined plane, from whence the stone might be made to slide into its position under such command as to adapt the mortises and tenons to each other for permanent juncture of the three stones in one mass.—The Architect and Contract Reporter.

Sixty cars will be provided with electrical equipment for the Boston Elevated Railway Company. The Sprague multiple-unit system will be used.

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